THIRD EDITION

Secrets of Bread Making

and

Economy and System in the Bakery

A HANDY MANUAL OF UP-TO-DATE MONEY-SAVING SUGGESTIONS AND FORM-SHEETS FOR SMALL AND LARGE BAKERIES, THE RESULT OF YEARS OF STUDY AND PRACTICAL EXPERIMENTS

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INTRODUCTION.

IT is now over fifteen years since the first edition of "Perfection in Baking," my initial effort in contributing to the baker's library was submitted to the trade. The preface of that Book explained its purpose. In part it read, *"It is the main object of this work to show in plain language all who are interested how to become successful in baking;* the theories of how to put together and how to change recipes, when the same grades or brands of material are not at hand. Judgment and common sense must be displayed to insure success." Well, the Book was a success and fourteen editions have been disposed of and there are thousands of bakers in the country to-day who will attest to having been benefited by the recipes and general hints in my first Book.

Some years later with the introduction of modern machinery and improved working methods, I was induced to prepare another Book that would be more up-to-date, more progressive. The introductory words in that work again suggested its purpose; it read—"The principal purpose of this work, as indicated by its title 'The Baker's Book' is to become every baker's *Hand Book.* It is not a recipe book; it is not a technical book; it is not a one man's book, but it embodies a whole library for any baker."

Now, after I proceeded with the work, I discovered that the material could hardly be compiled in one volume; it took Vol. I and II and then there was lots of

good material left. Now it goes without saying, the Baker's Book also made good. A set of Vol. I and II of "The Baker's Book" can be found in the public libraries of nearly all larger cities in America, it being recognized as a standard work. But as I came to realize the necessity or at least the advantage of a scientific training and understanding of the elementary principles or chemistry, the more I become convinced that there were thousands of bakers who have not the time or patience to study and go through whole libraries of technical books, besides caryring on tedious, time-taking experiments and observations, but who should be given an opportunity to learn the A. B. C.'s of practical science.

Again, many bakers seem to think, that because their shop and business are small there is no great necessity for accuracy in the various operations. But that is a mistaken idea. *Economy and System* in the small bakery will help materially, in fact are indispensible in laying the foundations for a successful, larger business. And as business built up on *Economy* and *System* keeps on growing, the practical, progressive baker must keep posted on economical improvements on machinery and tools and must study the ways and means of getting baked goods of the best possible quality at the least possible expense. To do this, it does not require any extra money, only a little study and sacrifice of a few spare hours to get acquainted with the principal laws of practical chemistry. The "System" end is just as important and shows up the leaks and weak spots in working methods and management.

Introduction

After several years of experimenting and study, condensing and rewriting copy on hand, I at last have succeeded to present this Book as a manual of practical instruction in such order in which it will be most useful and most likely to be retained in the memory.

As the author, I make no pretense to literary ability, but claim for this book the support of every baker in the land, on the ground of an earnest desire to impart to others the knowledge which I have acquired by consistent work and hard study during a busy life as a "practical baker."

Emil Braun

P. S. I have made it a special point not to mention any one firm or any particular brand of Material, Machinery, Ovens, etc. in the text of this book.

However, I have reserved some space for such leading Manufacturers and Millers with whose product I am personally familiar and for which I can vouch in every respect.

PART 1.

Elements, Compounds, Acids, Chemical Terms.

CHEMICAL KNOWLEDGE.

If we look at it right, every process in baking rests on "chemistry." Chemistry is largely a study of chemical changes and a branch of natural science. Every young man or boy who has entered a bakeshop with the intentions of learning the profession of baking, is really *a student in chemistry,* although comparatively few are conscious of this fact, and they look at their routine work as a necessary evil. The knowledge possessed by any competent baker, being exact knowledge, is in the truest sense "scientific" knowledge, and such accumulated knowledge in all stages and branches of baking is really its "science." The average baker hardly realizes what wonderful chemical changes are constantly taking place around him and right under his eyes and what great opportunities for study and experiments are at his disposal. Therefore every conscientious, progressive baker should know at least the elementary principles of such elements, compounds and chemical changes as enter into his daily work.

The first principle (technical chemistry) is transmitted to the baker by such technical chemists and is of comparatively little use to the average baker unless he understands, as he is supposed to understand *or should understand* at least the secondary principles or (*practical science*) of baking. While the mechanical baker goes ahead with his work like a machine after it is started, the chemist or scientific baker before he

enters into any work, asks himself: "Why do these changes occur? What do these materials consist of?"

All known substances are classified either as *Elements, Compounds or Mixtures* and we will give a plain, short explanation of such as are of value to the baker or applied by him in his daily work.

ELEMENTS.

Are such substances which can not by any known means be separated or split up into two or more substances. Although the chemist knows over seventy such elements, the majority of these are of no particular value or interest to the baker. Therefore I will only mention the most important ones. Each element is designated by a symbol which is generally the first letter of its name, for instance *O* is the symbol for Oxygen and *N* for Nitrogen.

Most of our metals are elements, such as gold, silver, copper, iron etc.

Other elements are called nonmetalic or metalloids.

These again are divided into *Solids,* such as Carbon and Sulphur and *Gases* like Nitrogen, Hydrogen and Oxygen. Others like Bromine and Mercury are *Liquids.*

As a number of elements have the same initial letter, the symbol of some is made up of two letters, for instance C represents Carbon while the symbol of Chloride is Cl. The symbols of other elements are taken from their latin names as indicated in the following list:

Symbol for Iron (Latin Ferrum) is Fe.
Symbol for Sodium (Latin Natrium) is Na.

Capital letters are always used for symbols or when two letters are used the first one is always a capital and no period is used after the symbol.

Name of Element	Symbol	Atomic Weight
Calcium	Ca	40
Carbon	C	12
Chlorine	Cl	35.5
Copper (or Cuprum)	Cu	63
Hydrogen	H	1
Iron (or Ferrum)	Fe	56
Magnesium	Mg	24
Nitrogen	N	14
Oxygen	O	16
Phosphorus	P	31
Potassium (or Kalium)	K	39
Sodium (or Natrium)	Na	23
Sulphur	S	32

A short explanation of the characteristics of the most important elements will help the baker to a better understanding of the chemical processes confronting him in his daily work.

CALCIUM (Ca) belongs to the group of so-called earth metals. It is not found pure and free, but its compounds and salts are very numerous, such as *Calcium Carbonate, Calcium Hydroxide, Limewater, Calcium Oxyde,* etc. (See Compounds.)

CARBON (C) is found in nature only in solid form, either as *Diamonds* or *Graphite* which are remarkably different from each other. Coal, Wood, Bones, Flour, etc. contain Carbon in a more or less impure state. The chemist terms this impure Carbon *Amorphous* Carbon. In fact, Carbon is a very important factor in the existance and growth of all plant and animal life. Carbon is of great importance to the baking industry. It forms a vast number of compounds in nature as well as artificially prepared.

In the large group of bodies, sugar, starch, etc., called *Carbohydrates* which are explained later on, carbon is always present. Also in all albuminous sub-

stances or *Proteins.* Carbon is one of the principal components. (See Compounds.)

CHARCOAL is another variety of carbon, which is obtained by heating wood or meat, bones, flour or other organic matter in enclosed vessels (without exposure to air) or by slowly or partially burning or charring them with little air. The process practically consists in driving off the volatile (gaseous matter) and retaining the carbon. Wood, charcoal and coke are more thoroughly treated in Part 5. One of the characteristics of charcoal is, that it absorbs any colored matter from liquids when filtered through charcoal. Animal charcoal used to be also used to clarify or bleach sugar. Charcoal also absorbs foul air and purifies water by filtration.

Carbon in connection with oxygen produces heat and *Carbon Dioxide* (CO_2), the gas which is of the greatest importance to the baker. This is more thoroughly explained under compounds and in Part 5 (Combustion).

CHLORINE (Cl). This element is never found in nature free, because it combines too freely with other elements. It is a gas with a suffocating, disagreeable odor which is very penetrating, as in the disinfectant *Chloride of Lime,* one of its compounds. The most important of these compounds for the baker is *Sodium Chloride* or common Salt. (See Compounds.)

Chlorine dissolves readily in water, thus being called *chlorine water.* When this solution is placed in the sunlight, the oxygen liberates and the resulting substance is *Hydrochloric Acid* or *Muriatic Acid.*

HYDROGEN (H) in its pure state, as a gas, has no odor, taste or color. It is the lightest known substance and is therefore used as the standard for reckoning the density of gases and atomic weight of elements and compounds. (See Atoms and Molecules.)

Hydrogen burns in air and in pure oxygen, but the pale blue flame is almost invisible, although the heat of burning Hydrogen is very intense. Hydrogen was first called inflamable air.

Compounds of Hydrogen *Hydrocarbons* and *Carbo-Hydrates* are of great importance to the baker and are more fully explained later on.

NITROGEN (N) is also a gaseous element, has no taste or odor and is colorless. It constitutes about 78 per cent of the atmosphere (by volume). It differs greatly from oxygen as it does not support combustion, neither will it burn or sustain life. It is not poisonous, for the air we breath, as stated above, consists nearly four-fifths of nitrogen (by volume). Its main function is to dilute the oxygen in the air. It is an important food for all plant life. It is an inert or non-active element but is found in a great many compounds, such as *Ammonia, Nitric Acid,* etc. Being itself non-active, it acts as a restraint to the more active oxygen. Nitrogen or its compounds are memtioned frequently by chemists in flour tests and in the bleaching of flour controversies nitrogen played a leading role. It is a little lighter than air and only slightly soluble in water.

OXYGEN (O) is a gaseous element and more widely distributed than any other known element. It is colorless, has no smell or taste and is slightly heavier than air. The most striking characteristic of oxygen is its chemical activity and great affinity towards some of the other elements, especially carbon. Oxygen is necessary to all forms of animal and plant life, as it forms one-fifth (by volume) of the air or atmosphere and eight-ninths (by weight) of water. The importance of oxygen in producing heat or sustaining fire is thoroughly explained in Part 5. Also in Part 2 and 3 Oxygen is referred to quite often, especially in fermentation.

OXIDES. When oxygen combines with other elements, the resulting compounds are called Oxydes. Oxydation means a chemical change. The rusting of iron and other metals, the burning of other elements, carbon, sulphur, etc. is principally oxydation. Decay is also a form of oxydation and decomposing of sugar into alcohol and carbon dioxide may be termed as oxydation. (See Fermentation.)

Oxygen forms a part of most every manufactured chemical product. Its specific volume and weight is explained later on under Atoms and Molecules.

PHOSPHORUS (P). This element is not found in a free state in nature, but its compounds (phosphates) are numerous. Phosphorus ignites very easily which makes it dangerous to handle. It is very poisonous and burns from it are very painful and hard to heal. When exposed to the air, it gives off white fumes and in the dark or in moist air it glows or shines, which you can see by rubbing the head of a match in a dark room. Phosporus and its compounds are very essential to the growth of plants and animals as it is called a bonemaker. Bones contain often as high as 60 percent of calcium phosphate.

POTASSIUM is a metal, which however, is not found free, but there are a great many compounds of this element. The mineral *Mica* contains a large percentage of potassium.

SULPHUR (S) has been known for ages. Ordinary sulphur of commerce is a brittle, yellow, solid substance. It is insoluble in water and is also a poor heat conductor. Sulphur ore is mostly found in volcanic regions and requires purification by melting after which it is popularly called Brimstone. It melts very rapidly at about 260 degrees F. It ignites very easily and burns with a pale blue flame, the escaping vapor being Sulphur Dioxide (SO_2).

COMPOUNDS.

When Elements or Substances unite or combine with each other, the resulting body or product is called a *Chemical Compound.*

In Newell's descriptive Chemistry are mentioned three essential characteristics of such compounds:

1. Their components are held together by chemical attraction. For instance, Hydrogen and Oxygen, the components of water, can not be separated unless their attraction for each other is overcome by heat, electricity or some other agent.

2. In any given chemical compound the elements or components are always in the same ratio or proportion. For instance: Pure common Salt, however prepared or wherever found, always contains 39.32 percent of sodium and 60·68 percent of chlorine. Or as another example water always contains eight parts (by weight) of Oxygen and one of Hydrogen.

3. In chemical compounds the identity of the components or different substances is lost. For instance: Copper (red metal) and Sulphur (yellow, solid) and the invisible gas Oxygen, are the substances which make the blue colored solid Copper Sulphate.

There is a distinction between *Organic and Inorganic* compounds.

ORGANIC COMPOUNDS are generally understood such which have some connection with living organisms, animal or vegetable, or carbon compounds. Although their number is very large, they are composed of very few elements.

Hydrocarbons for instance, found in natural gas, petroleum, etc., contain principally carbon and hydrogen. Fats are also heat producing hydrocarbons.

Carbohydrates or vegetable compounds, such as starch and sugar, contain oxygen in addition to carbon and hydrogen. Albuminoids or Proteins, which we find in egg albumin, gluten, gelatine, muscle, etc., contain generally nitrogen as well as hydrogen, carbon and oxygen, some also contain sulphur or phosphorus in small proportions.

Other organic compounds are Ethers, Alcohols, Acids, etc.

INORGANIC COMPOUNDS. This term is generally used for mineral elements and their compounds or the constituents of the inanimate, lifeless portions of minerals of the earth.

These terms *organic* and *inorganic* are still used in chemistry, but their original narrow meaning has been greatly broadened since it has been discovered that some organic compounds can be prepared from inorganic substances. Organic chemistry is also often referred to as Chemistry of Carbon Compounds.

MIXTURES.

These must not be confused with compounds. Unlike a compound (see above) you can mix different bodies in different proportions, such as sifting together one sack of dark flour and one sack of white flour. The color then will be different from either one separate, but still it is only merely mixed and the particles of each flour stay separate, and all is still only flour. *No actual union or chemical change has taken place.* Or if you sift and mix together certain quantities of cream of tartar, soda and flour you will call it baking powder. You sift it a number of times to get it thoroughly mixed, but still you only have a mixture and each ingredient retains its own character as long as kept dry.

ACIDS

are chemical compounds and have more or less sour or acid taste, due to the presence of hitrogen. The acid content of any substance can be found out with blue litmus (litmus paper) which turns red in an acid solution. For a determination of the acid of flour a more definite acid test is obtained with other chemicals. (See Flour, Part 3.)

Acids also have the power to decompose most of the carbonates like limestone, thereby liberating carbon dioxide gas, which escapes with effervescence. *Effervescence* means this: When certain substances are put together or exposed to the air, a commotion takes place and some part of the mass or liquid flies off in a gaseous form, producing a lot of bubbles and raising up as if it was boiling.

Most acids are soluble in water and are called either dilute solutions or concentrated, according to the strength of such solutions. Some acids are liquid, such as sulphuric and nitric acid, lactic and acetic acid; others are gases such as hydrochloric acid and others are solid, like tartaric acid, citric acid, etc.

The more important acids of interest to the baker are:

	Name of Acid	Symbol of Formula
1.	Acetic Acid	$C_2 H_4 O_2$
2.	Butyric "	$C_4 H_8 O_2$
3.	Citric "	$C_6 H_8 O_7$
4.	Hydrochloric Acid	$H Cl$
5.	Lactic "	$C_3 H_6 O_3$
6.	Palmitic "	$C_{16} H_{32} O_2$
7.	Sulphuric "	$H_2 S O_4$
8.	Stearic "	$C_{18} H_{36} O_2$
9.	Tartaric "	$C_4 H_6 O_6$

ACETIC ACID is the most common organic acid. The commercial acetic acid is manufactured principally by distillation from wood and seldom contains more

than 30 *per cent.* of pure acetic acid. This is known also as *wood vinegar.* The common *vinegar* is also a mild solution of acetic acid produced from a combining of alcohol with oxygen (oxydizing) through fermentation. This transformation can be accomplished by two different processes, which Professor Newell quotes as:—

1. When beer, weak wine or cider are exposed to the air, they slowly become sour owing to the conversion of alcohol into *acetic acid.* The change is caused by the presence and activity of a ferment, known as *mycodermuce acedi* or *mother of vinegar.*

Strong wines and pure dilute alcohol do not become sour, because the ferment cannot live in such liquids.

2. In the "quick vinegar process" impure dilute alcohol is oxydized by exposing it to an excess of air.

The formation of Acetic acid or Acetic fermentation is explained in chapter on Fermentation, (Part 2).

BUTYRIC ACID is the acid which in combination with capric and caproic acid gives butter that pleasant flavor, but if present in too great a proportion it causes butter to become rancid. In bread fermentation, butyric acid or butyric fermentation follows closely or develops (only in smaller proportions) along with the lactic acid. (See Part 2.)

CITRIC ACID is principally obtained from the lemon, but can also be abstracted from various other fruits. It is vegetable or fruit acid. It is sometimes adulterated with tartaric or mineral acids. When the question of a lemon flavor or tartness is to be considered, the preference is given to citric acid by the baker or confectioner, because it is stronger in acidity than tartaric acid. But it is little used in manufacturing of baking powders, because it is very susceptible to dampness and therefore must be kept in a dry atmosphere and tightly sealed.

HYDROCHLORIC ACID is a transparent, colorless gas. When it escapes into moist air it forms fumes or vapors which have a choking, sharp, pungent odor. This gas does not burn, neither does it support combustion. It is 1.25 times heavier than air. It is soluble in water, and this solution is known at *Muriatic Acid*. This solution is manufactured in large quantities and is used extensively for bleaching purposes.

A mixture of salt and sulphuric acid moderately heated produces this acid.

LACTIC ACID is a syruplike liquid and easily decomposed by heat. Lactic acid is quite an important factor in bread making and it is the so called lactic fermentation which gives the bread that pleasant, nutty flavor (see Part 2). Lactic Acid is the most prominent acid in the total acid bodies contained in flour, (over 90 per cent). Therefore, in making acid tests of flour, the same *are based on or expressed as lactic acid*. Lactic Acid is also the cause of milk turning sour, being one product of the fermentation of the milk sugar. When sour milk is used in baking, the necessary carbonic gas (carbon dioxide) to raise the dough, is produced by adding sufficient baking-soda (see Alkalies) which interacts with the lactic acid in the sour milk. The original cause of lactic acid is a specie of bacteria called bacterium-lactis, which are always present more or less in the atmosphere. They are also said to be present in varying numbers on the surface of Malt and in yeast.

PALMITIC ACID is one of the principal compounds in palm oil and also present in olive oil and animal fats.

STEARIC ACID is found as a compound in nearly all fats, but principally in beef suet and mutton fat. Both of these acids are white solids.

SULPHURIC ACID is an oily liquid, colorless when pure, but as we usually see it, it has a brown color, due to the presence of organic matter. When you add water to it, a great deal of heat is evolved, and if this is not carefully done and slowly, the intense heat may cause an explosion. It is used directly or indirectly in a great many industries.

TARTARIC ACID is a white crystalized solid, soluble in water or alcohol. It is found as potassium salt in grapes and some other fruits. It has a tart, sour, but not unpleasant taste. It is deposited during the fermentation of grape juice in an impure or crude state in the casks. When pure, it has between two and three times the neutralizing strength of cream of tartar.

Cream of Tartar is obtained in the same way as tartaric acid. Its quality and purity depends greatly on the care taken and time allowed during the refinement. In the pure state it is produced in crystals, but the Cream of Tartar of commerce is generally sold in powdered form.

Cream of tartar, like tartaric acid, interacts with bicarbonate of soda, neutralizing the latter, carbon-dioxide being produced.

However, cream of tartar dissolves and acts slower than tartaric acid, and for that reason is preferred by the bakers. There are some substitutes on the market claimed to be as strong or stronger than pure cream of tartar, but these are produced from phosphates and they usually produce gas too rapidly and the power is exhausted before the baker can get his biscuits or cakes into the oven. Cream of tartar is supposed to neutralize half its own weight of bicarbonate of soda when pure. Genuine cream of tartar is called 99 per cent pure. Both cream of tartar and tartaric acid absorb moisture very readily, and should be kept in tightly closed cans or jars.

BASES or ALKALIES.

Bases are commonly known as *alkalies,* which means any substance that will neutralize an acid. Most bases are solids and are usually soluble in water. Any substance which will turn red Litmus paper to blue, is understood to contain an *alkali* or base, or to have an *alkaline* reaction Most of the stronger alkalies like *Caustic Soda,* have a slimy, soapy feeling and a very bitter taste. Alkalies also dissolve grease and fats and we use them, especially caustic soda, in water solution for cleaning bread pans and greasy floors. All alkalies absorb moisture and thereby lose their strength; therefore they should be kept air tight.

Litmus or sometimes called *Lacmus,* is a peculiar coloring substance which is obtained from certain species of lower parasitic plants or fungus, called *Lichens* (*Roccella tinctoria*). These *lichens* grow on the rocks in certain mountainous portions of the world, principally in the Alps. *Litmus* has the peculiarity of turning from its original blue color to red by the reaction of acids and is restored to its original *blue color* by *alkalies.* It is therefore used extensively for the purpose of determining the strength of reaction of various liquids.

BICARBONATE of SODA or baking soda, as stated before, is obtained through a chemical process. Commercial baking soda is supposed to be at least 95 per cent pure and is used by the baker in connection with an acid, usually cream of tartar as a raising substance for cakes and biscuits. The baker should by all means avoid any cheap, common soda, as good neutralization of the acid is very important and a bad color, reddish, and a bitter flavor of the baked goods may be the result.

In connection with molasses for cakes or brownbread or with sour milk, it may be used alone without an acid; when mixed in the dough, the acid in the sour

milk acting on the soda and the heat of the oven will liberate the carbonic acid gas, which makes the cake or bread raise very quickly.

The manufacturers of some of the best known brands of baking soda sold, guarantee their soda as 99 per cent pure, containing over 52 per cent of carbonic acid gas, which means for each pound to create 5 cubic feet of the gas. Baking Soda or Carbonate of Soda or Sodium Bicarbonate is also known as *Saleratus,* which means the salt which aerates.

AMMONIA proper is a colorless gas, possessing a very *pungent, peculiar, strong smell*; but the same name is used for its solution in water, although the chemical term for the latter is ammonium hydroxide. This solution is a strong alkali or caustic alkali, which neutralizes the strongest acids and forms salts. Ammonia is one of the most important compounds of nitrogen. When you heat any animal substance containing nitrogen, ammonia is given off. During the decay of any vegetable or animal matter, which contains nitrogen, the nitrogen combines with the hydrogen and escapes as ammonia. A strong ammonia odor is noticeable near stables, and especially when the dung pits are emptied. Ammonia used to be extracted principally from horns and hoofs of deer and other animals, by heating the same in closed vessels which is called dry distillation, the product frequently being termed "spirits of harts horn." The German expression "Hirschhornsalz," has the same origin. Ammonia and its compounds are now, however, mainly obtained from gas works. When soft coal is burned to make illuminating gas, one of the by-products is ammonia. Ammonia is decomposed by heat, and carbon dioxide is generated, which in escaping, forms the leavening power.

Ammonium Carbonate is the compound used by the baker and often called "Volatile." When kept from the air, it is a hard, semi-transparent, stonelike

substance, but decomposes or softens very readily in the air, losing some of its strong, disagreeable smell at the same time and gradually falling apart as a white powder. It is then called Bicarbonate of Ammonia. The baker prefers to buy the hard or "green" ammonium, as it has a stronger leavening power. Through exposure and evaporation it loses about half its weight and strength, but little in bulk and also dissolves much quicker in water or milk. Ammonium Carbonate is not always uniform in strength and quality and therefore somewhat uncertain in its action and the results obtained are not always satisfactory. This accounts for the difference in lightness of different batches of cakes as well as the unequal smell and color, although the regular formula has been strictly followed. Occasionally you find, that cookies or biscuits in which bicarbonate of ammonia has been used, will smell strongly of the ammonia when coming from the oven, or have a reddish color. This may be caused by an overdose of the ammonia which has in consequence not been fully neutralized by the heat of the oven, or it may have been of inferior quality.

There has been some agitation condemning the use of Bicarbonate of Ammonia for baking purposes as a dangerous article and a poison. This is absurd, as in no book on chemistry, either caustic ammonia or ammonia combined with any other substance is mentioned as a poison. The carbonate of ammonia which is added to your dough or mixture, leaves no residue whatsoever; it completely evaporates in the baking heat even at a lower temperature than the baking heat, say, 160 to 180 degrees F.

Commercial carbonate of ammonia is composed of:

Carconic acid	55 per cent
Ammonia	30 per cent
Water	15 per cent

Both these substances are volatile, the carbonic acid evaporates at about 150 degrees and the ammonia at

170 degrees, consequently the leavening power is about 85 per cent. Carbonate of ammonia does not melt; it completely evaporates. You can convince yourself of its purity by making the following test:

Place a small piece of the carbonate of ammonia in a small evaporating dish and heat it. The ammonia will be gradually transformed into gas, no residue or ash being left, only a strong ammonia smell is noticeable, which, however, disappears very quickly.

LIMEWATER has a strong alkaline reaction and therefore turns red litmus paper blue. It is a solution traced back to Calcium carbonate or limestone. When this is super-heated or burned in kilns, the gases are driven off and the remaining substance is called Calcium Oxide, *Quicklime* or Caustic Lime, which eats up or destroys organic matter. When exposed to sufficient water, it forms a white powder, called *Calcium Hydroxide,* a solution of which is the limewater sold in the drug store.

The limewater, as the baker knows it, for pickling eggs, or to check or neutralize undesirable acids in dough or to soften hard water, is a solution of slacked lime with plenty of cold water. But, as water absorbs only a small percentage of lime, there will very likely be a sediment of lime at the bottom; pouring off the liquid on top, you can pour on some more cold water, stirring up the lime from the bottom, then after it has settled, you can pour off the limewater again. This can be repeated several times.

SALTS.

A SALT may be defined as the main product of the interaction of an acid and a base. There are, however, substances which have the properties of a salt regardless of different method of formation.

Most SALTS are solid and soluble in water. Such salts in which the hydrogen atoms of the corresponding acid have been replaced by a metal, are known as *normal salts.* When some of the salts is not replaced by a metal, the resulting substance is known as an *acid salt.*

But besides the above way, salts can also be produced by the interaction of acids with oxides of some metal or with the metals themselves.

A salt which has no action on litmus is called neutral.

The most familiar salt is of course, our common table salt (sodium chloride) NaCl. Salt is found in sea water, rock-salt and brines. Sea water contains nearly four per cent of salt, and in some countries the sea water is evaporated by the sun and wind. Salt deposits in England, Austria and Germany and to some extent in the U. S. are found in the ground and the salt is mined and purified. Most of the salt used in this country is obtained either from natural or artificial brines or strong solutions of salt, made by forcing water into the salt deposits.

Salt is soluble in cold or hot water, but the difference in temperature of the water has little effect, as hot water does not melt it any faster. 100 parts by weight of water will dissolve about 36 parts of salt. Boiling water will absorb hardly four parts more. Salt readily draws dampness from the air, which is mainly due to the presence of magnesium chloride. Therefore it is to be recommended to the baker to use a refined salt, which is drier and not so easily affected by dampness. The effects of salt on fermentation, etc., is explained more thoroughly later on.

MATTER and FORCE or ENERGY

are two of the fundamental laws of Chemistry.

MATTER means any substance which has weight, be it a solid like iron or a liquid like water or a gas like

air. All substances or matter are recognized and distinguished by their properties. Color, odor, weight, taste and their solubility are familiar properties of matter, but the chemist also considers their behavior or action with heat, light and electricity, as well as the action of different kinds of matter upon each other.

The properties of matter can be changed, but not destroyed. In some cases the change is only temporary as in the freezing of water or melting of iron. Such changes are called *physical changes.* But when the change is permanent, as in the burning of coal or the digestion of food, the change is called a *chemical change.* Physical and chemical changes are closely related and are often inseparable. When a substance or several substances undergo a chemical change, it is called a *chemical action.* When such chemical action involves several substances, it is called a *reaction.*

Analysis means decomposition of compounds or the separation of matter into its original components.

FORCE is really ENERGY.

Any exertion made to act on a body is force.

The strength of a man's arm is a force, so is the power of a horse to pull a wagon. The wind is also an invisible force, able to tear down houses and trees or to move ships on the water.

Heat, light and electricity are different forms of energy, producing special changes. It is also possible to transform the different kinds of energy into each other. Electricity, for instance, is generated from the heat liberated by burning coal, and this electricity in turn can be transformed into light.

Chemical energy, or a chemical attraction is an important factor in all chemical changes. But although in such chemical changes *matter* or the original substances are often transformed and apparently lost or destroyed, the total weight of the substances participating in any chemical change is always the same. It

follows that—*Matter cannot be destroyed or lost and no weight is lost or gained in a chemical change.*

ATOMS and MOLECULES.

ATOM means the smallest particle into which an element can possibly be divided. The Atomic Theory as first proposed by John Dalton assumes:

1. That the chemical elements consist ultimately of a vast number or very small, indivisible particles or *atoms.*

2. That the atoms of the same element have the same weight.

3. That atoms of different elements have different weights.

4. That chemical action is union or seperation of the atoms of the elements.

The chemist of to-day, assumes that atoms do not, as a rule exist in the uncombined state. As soon as atoms free themselves from one combination, they at once unite with some other atom or a number of atoms.

MOLECULES. According to above theory we learn that the smallest particle of matter or of any substance which can exist independently or alone is not an atom, but a group or combination of atoms, which are known as *molecules.* If the atoms composing a molecule are atoms of the same element, then the molecule is a molecule of an element; but if the atoms of different elements are combined, then the molecule is the molecule of a compound. For instance, the smallest possible particle of a drop of water is a molecule of water, but this insignificant little mite or molecule of water contains still smaller particles, namely atoms of hydrogen and oxygen, the elements of which water consists. (See Elements.)

CHEMICAL SYMBOLS and FORMULAS.

SYMBOLS and their signs have been explained under chapter of Elements and in Part 5, but the letters only represent single atoms of each element. For instance, O means just one atom of Oxygen; H one atom of Hydrogen, etc. If we want to indicate more than one atom of any element, we place the proper number before the symbol, for example:—

2O means 2 atoms of Oxygen.

3N means 3 atoms of Nitrogen.

However, when the atoms are to represent a compound, or are in chemical combination, then a small number is placed after and below the symbol like this:—

O_2 means 2 atoms of Oxygen in combination.

N_4 means 4 atoms of Nitrogen in combination.

FORMULA. A chemical formula means a group of symbols, designed to express the composition of a compound. In writing a chemical formula, the symbols of the different atoms making up the compound are placed side by side.

Therefore, the formula for water is H_2O, which means that the molecule of water is composed of two atoms of hydrogen and one of oxygen. Hydrochloric acid has the following formula, HCl, which tells us that the molecule of this acid is composed of one atom of hydrogen and one atom of chlorine.

CHEMICAL EQUATIONS. When we want to express the different facts of chemical reactions or changes, the proper symbol and formulas are used, which is called an equation.

Let us repeat the previous example of the formula of Hydorchloric acid again, which is:—

$$H + Cl = HCl.$$

Hydrogen (1 atom) Chlorine (1 atom) Hydrochloric acid (1 molecule). If we want to represent several molecules, we set the respective number or figure (in large type) in front of the formula.

Another example:—

$$2H_2 + O_2 = 2H_2O.$$

Hydrogen, 2 molecules each 2 atoms.	Oxygen, 1 molecule, 2 atoms.	Water, 2 molecules, 4 atoms Hydrogen, 2 atoms Oxygen.

ATOMIC WEIGHTS. We have learned that all matter has weight, even the invisible gases and air. A bottle filled with air, for instance, weighs more than the same bottle if the air is forced out of it. Therefore, no matter how small an atom of any element is, it has weight. As stated before, (see Elements) it has been found that Hydrogen is the lightest known element. Therefore, the atom of Hydrogen stands for one (1) and the weights of atoms of other elements are expressed in the relative numerals. For example, when we say the atomic weight of oxygen is 16, it means that one atom of oxygen has 16 times the weight of an atom of hydrogen; or if we could place one atom of oxygen on the one pan of a scale, we would have to put 16 atoms of hydrogen on the other side to balance it. But, as we have no balance sufficiently delicate to determine the exact weight of a single atom, the atomic weight is determined by indirect means, and many principles influence the numbers finally adopted as the atomic weight.

MOLECULAR WEIGHTS. As we learned before, atoms combine and form molecules.

Therefore, the molecular weight of a compound is the sum of the weight of the atoms in a molecule.

Just as the symbols stand for atomic weight, so the formulas express the molecular weight. For example:

Acetic Acid: the formula reads $C_2H_4O_2 = 60$.

How do we get the 60?

Carbon, 2 atoms; atomic weight being $12 \times 2 = 24$
Hydrogen, 4 atoms; atomic weight being $1 \times 4 = 4$
Oxygen, 2 atoms; atomic weight being $16 \times 2 = 32$

60

It does not matter what weight the different parts represent, whether grams, ounces or pounds, the proportion or relation to each other will always be the same as by atoms and molecules.

NOTE—It has been my honest endeavor to explain the fundamental principles of Chemistry, or explanation of chemical terms, in as condensed but simple a way as to make it comprehensive to every baker. However, to every young baker who has the time or patience to go deeper into the mysteries of Chemistry, I would strongly recommend Prof. Lyman C. Newell's book, "*Descriptive Chemistry.*"

PART 2.

Yeast, Fermentation, Yeast-Foods, Bread Diseases.

Yeast and Fermentation are so closely related, that it really makes little difference which we explain first. The name fermentation originally was given to a peculiar but very interesting class of decompositions. It has been known for ages that many organic bodies are liable to ferment if exposed to certain organisms, which are called "Ferments." The dust in the air contains such ferment organisms; but the air also contains other organisms, bacteria and moulds; for instance, stale bread becomes covered with mould; shoes or books left in a damp place become mouldy; wine, beer or milk become sour when exposed to the air which is hastened when the temperature of the air is above 60 degrees (F).

YEAST.

Yeast has practically been known and used for thousands of years. The Egyptians obtained some "wild yeast" from the air and started a dough with it. From the first baking a portion of the dough was saved and used to start the dough for the next day's baking; this was called "leaven." You can gather and cultivate such "wild yeast" by exposing a dish of Malt Extract, Glucose or other fermentable sugar solution to the air. Alcoholic fermentation will soon set in, and as alcoholic fermentation can only be pro-

duced by yeast, consequently the yeast plants or yeast fungus must have been present in the atmosphere. But as stated above, there are other organisms or bacteria floating around in the same air which are detrimental to a healthy yeast growth if they drop into your ferment started with the desirable or healthy yeast. The same method of starting and raising the bread dough with "leaven" is still carried on in France and other countries of Southern Europe, only more care is exercised in nursing the dough along. (See Fermentation.)

I presume that every baker knows today that yeast is a plant of the most simple structure, consisting of chains of small, round or oval cells or of single cells which grow vigorously and multiply thousand fold if given the proper food or nourishment, particularly a liquid containing principally sugar in some form. However, the chemist tells us that yeast requires for its existence and growth, lots of other substances or elements such as oxygen, nitrogen, phosphorus, carbon, hydrogen, mineral substances, proteins, etc., but which must be so combined as to be ready for immediate assimilation.

Yeast belonging to the family of Fungi, grows or multiplies by "buds" and "spores." *Budding* of yeast cells means, the mother cell produces several buds which break away as new plants and cells, afterwards repeating the same process. This process goes on very rapidly and in a short time there are millions of such cells.

SPORES are practically young yeast cells nursed within the covering or hull of the mother cell. In a short time the covering breaks and the young cells are set free to shift for themselves. However, yeast spores are only formed when there is only little food available for the yeast cells and the spores will not bud or grow as fast into budding plants as the buds

set out under more favorable conditions, or having better food.

The chemists in speaking of yeast, use so many different words, for instance: yeast plant, fungus, bacteria, germs, bacilli, minute organisms, etc.; besides in these lower minute forms of life which you have to magnify about 500 times to make them visible, it is a difficult task to distinguish or keep apart bacteria (plant) from microbes (animal). The French chemist Trouessart, gives us the most simple explanation: *"We shall make use of the term microbe as the general designation of all the minute organized beings which are found on the borderland between animals and plants."*

The baker may easily get confused, having all these different terms mentioned in connection with yeast. The different kinds of yeast, such as Hop yeast, Barm yeast, Dry yeast, Compressed yeast, etc., are really mixtures of different substances, only one of these substances however being yeast, the rest is food for the yeast plants. Other species of fungus or little midgets of invisible microbes or bacilli will grow in the same food as the pure yeast cells, if they get a chance, but then the fermentation will get "wild" or putrefaction may set in.

Therefore, it is very essential that the yeast cells or yeast plant is kept from contamination and supplied with the proper *yeast food.* Healthy yeast, sufficiently active and added in sufficient quantity in addition to causing the dough to rise by the production of alcohol and liberation of gas, also prevents or at least checks the development of other bacilli, such as butyric and lactic, or in other words, prevents the dough from getting too "acid" or sour. Such bacilli only become abundant or dangerous after alcoholic or yeast fermentation grows weaker and gets exhausted. (See Fermentation.)

The yeast cells for a heatlhy growth require:—

1. Warmth (78 to 90 degrees F is the most favorable temperature).

2. Moisture.

3. Food, which as already stated consists of nitrogenous matter, mineral matters and sugars (Carbohydrates).

4. Oxygen, which it gets from the air.

As the yeast grows or the cells multiply, they break up the sugar, forming alcohol and carbon-dioxide gas which forces its way between and gets entangled in the tenacious particles of the gluten which keeps the gas from escaping too quick and thereby the dough is raised and made porous.

On account of the great many ways or methods of growing or cultivating yeast, there are different kinds or species of yeast. These are all closely related and very much alike in appearance and all produce alcoholic fermentation. But although grown in a similar wort, they develop some distinctly different by-products or different flavor in the fermented liquids. The yeast cells of wine, beer and those raised in whiskey distilling, each produce a different taste and flavor. From the last named source, (the distilleries) nearly all the compressed yeast is obtained.

The strength and flavor of any yeast depends a great deal on the care with which it is made and preserved. Temperature plays an important part in yeast cultivation.

The compound barm of the Scotch bakers or practically all stock yeasts or barms, although prepared in many different ways by different bakers, depend principally on the stability furnished by the hops and the diastasic properties of the malt. Sugar, scalded flour and potatoes are also used more or less in these liquid yeasts and barms.

BREWERS' and distillers' yeasts are formed from hops, malt or other liquors which have been boiled down in large vats. This is called the mash. In their case the yeast is cultivated principally for the purpose of giving the product (such as beer, ale, whiskey, etc.) the proper flavor. The yeast is a by-product with them. But as they make yeast a special study, and as they know just which specie of yeast gives them the desired flavor, they watch their yeast cultures pretty close, so as to keep away all "wild" yeast cells and objectionable ferment bacteria. There are two kinds of liquid yeast; "top" yeast and "bottom" yeast. The difference between the two lies mainly in the difference of temperature. At a temperature of from 60 to 80 degrees (F) fermentation in the mash or wort (already stocked with yeast) gets more vigorous. The increasing amount of carbon dioxide gas, as already explained, forces its way to the top of the liquid in the vats in numerous bubbles, carrying along the yeast cells which settle on top into a sticky, thick scum. This is called "top" yeast.

At a lower temperature, especially below 50 degrees (F), fermentation progresses less vigorously and much slower, the gas is not so active and does not send near so many nor near so strong bubbles to the top and consequently most of the yeast sinks to the bottom of the vats and settles there. This is "bottom" yeast.

COMPRESSED yeast is produced by alcoholic fermentation of malt or other grain worts. On account of the large amounts of moisture in the yeast (estimated by Hayduck to be 73.5 per cent) a small amount of pure starch (corn, rice or tapioca starch) is usually added by the manufacturers, before the yeast is pressed; besides they claim that this preserves the yeast.

The most important point in favor of using compressed yeast manufactured by a reliable firm, is the

fact that you can depend more on its uniform strength and quality in all seasons of the year and in any kind of weather. Of course the baker must do his share in keeping this compressed yeast always in a dry, clean refrigerator at the proper temperature. Compressed yeast should be kept always in a temperature of not below 40 degrees (F) or not over 60 degrees. Where it is impossible to get compressed yeast fresh oftener than once a week, I have found the yeast will keep fresh for some time if kept in a very clean jar or crock of cold pure water. The yeast will settle at the bottom and the water can be poured off every two days and replaced with fresh water. In this way and if kept away from sunlight and heat (keep close to 40 degrees) the yeast will keep its vitality for some time. But care must be taken that no sugar, malt or flour gets into the water or else the yeast will start to ferment and go bad. Even a few bread crumbs dropped in accidently will start a disturbance and spoil it.

DRY yeast can be prepared from almost any good healthy liquid stock yeast. Wheatflour and cornmeal is added sufficiently to make a dough stiff enough so it can be rolled and cut into thin squares or cakes, which are then kept exposed to dry air until all moisture is taken out. Such dry yeast has been used extensively in starting ferment and new mother yeast or stock before the use of compressed yeast became so universal.

FERMENTATION.

Fermentation is a fundamental and most important subject in bread baking. It requires continuous attention and the most practical experience. You may have the best flour and other materials at your disposal and the most up-to-date equipment, but if the fermentation is imperfect and the doughs do not get ready at the proper time, the whole business is demoralized.

The term *"Fermentation"* itself is derived from the latin word *"fervere"* (to boil) and *"fermentum"* (yeast) so that strictly taken by its meaning it refers to a boiling process. Saying a ferment is boiling, however is speaking only figuratively. When for instance in beer brewing, some yeast is added to the sweet, warm liquor or wort, we notice a lively agitation and bubbles start to come up and soon the whole mass seems to be boiling. But as already mentioned in chapter on yeast, the bubbles are only the escaping carbonic acid gas (carbon dioxide).

However the term "fermentation" is very broad and a great many theories established by such great chemists as Pasteur, Liebig, Thénard and others have been contradicted again as scientific researches progressed in the study of fermentation and Zymology. Mr. Kirkland disposes of the matter correctly in one short sentence:—

"The process of fermentation is the act of an organism seeking its own growth and development." This is called the *"germ"* or *"vital"* theory of fermentation now generally recognized. As mentioned above, besides the yeast plant, which we can culture and control, nature provides a great number of species of wild fungi and bacteria, microbes and bacilli, all capable to start or promote some kind of fermentation.

Fermentation or Nitrification is also the process by which all vegetables and animal substances ultimately undergo destruction or decay and finally return to the inorganic world (the soil) in the form of Carbon dioxide,—Water, Ammonia, Nitrogen, etc. —to become again valuable food for plants, and under the influence of the sun rays again to generate different organic bodies or compounds.

This practically proves again the indestructibility of matter.

The development and character of fermentation is greatly influenced by temperature, and fermentation ceases almost entirely below 40 degrees (F) or above 140 degrees.

The principal forms of fermentation which interest the baker are:—

1. ALCOHOLIC fermentation, producing principally alcohol and carbon dioxide.

2. ACETOUS fermentation. Here we recognize again two divisions.
a. Lactic fermentation the main result being *Lactic* acid.
b. Acetic fermentation the alcohol being turned into *acetic* acid.

3. BUTYROUS or putrefactive fermentation the main product of which is butyric acid.

4. VISCOUS or mucous fermentation which causes beer to become gummy and sticky and is also suspected of causing "rope" in bread. (See Acids, Part 1.)

Fermentation is further divided into two distinct classes as applied to chemical action, these are:—

1. ORGANIZED ferments such as yeast, bacteria, etc.

2. UNORGANIZED ferments or ENZYMES.

The first are called organized ferments because they contain life; pure cultures or new plants can be raised or grown from the original stock the same as seeds of larger plants, sown in the soil, germinate and grow. We have explained them in previous chapter.

The second class, ENZYMES are chemical substances which are not living organisms but are produced by living organisms.

Such substances or *enzymes* are present in the yeast cells, malt, flour, etc., and the chemist recognizes quite

a number of different enzymes; *Zymase, Invertase, Diastase, Maltase,* etc.

Invertase is the substance or ferment which changes cane sugar or sucrose into glucose.

Zymase acting on sugars produces the alcohol and carbondioxide.

Diastase changes raw starch into soluble starch and then into maltose and dextrose.

However, before any of those Enzymes can become active, they must get in contact with plenty of water. This is called *Hydrolosis.*

ALCOHOLIC fermentation can be started with any kind of yeast—liquid, compressed or dry yeast. In fact, whenever fermentation is mentioned in connection with breadmaking, it means "alcoholic" unless otherwise mentioned. Alcoholic fermentation progresses best in a sponge or dough at a temperature between 78 and 86 degrees (F). Flour and water (for sponge) and other ingredients (for doughs) are mixed with a specified amount of yeast, the temperature of the water being calculated to give the sponge or dough the desired temperature; which varies according to conditions of weather or shop. The sponge or dough is then set away and fermentation will soon start. The yeast will start budding and as the yeast is looking for food, it changes the fermentable substances or carbohydrates into alcohol and carbon dioxide gas. While trying to escape as already mentioned (see Yeast) these gases will expand and puff up the dough (held in check by the gluten) making the sponge or dough light and porous. But as soon as the amount of alcohol produced by the yeast gets too large, (over 10 per cent of the total liquid) fermentation slows down and finally ceases, or in other words the further growth of the yeast has been stopped; the cells are dead, having been choked and killed by overproduction of alcohol caused by the yeast itself.

In fact it is a peculiarity of all ferments, that they keep on producing such substances as they need for their own food in such superfluous quantities, that they (these substances) in time put a stop to the activity of the yeast or other ferments.

This is one of the most important points in the whole process of breadmaking and requires the most study, experience and care of any baker. It is up to him to know the proper time when to check the alcoholic fermentation, by knocking down the dough first and second or third time, or if necessary when to cut over the dough and later, when to put the loaves in the oven. This will be explained more thoroughly in Part 3, under Doughmaking.

ACETOUS fermentation. A great many bakers imagine or take it for granted that all acetous fermentation produces sour bread; but that is not so. Most all the materials used in a bread dough contain more or less acid bodies—the flour and yeast, the fat and malt; even the air and the water used in dough making contain large quantities of oxygen, and as we learned in Part I, oxygen produces all kinds of acids or acid salts through oxydation.

We might accept this as a fact:

"That acid producing germs of one kind or another, or several species at the same time, are always present in every form of bread making and in every country."

Acid is always there, whether it can be tasted or whether it is concealed or hidden from the palate by an excessive amount of salt. Salt is the principal ingredient which will check acidity in a dough. The acid germs have also a certain action on the gluten, the gliadin, especially being softened. The protine matter of the flour changes into protones and this paves the way for another change by a putrefactive ferment, known as the *Bacterium termo*. The increase or development of the acidity in a dough however depends

almost entirely on the temperature of the dough. (This is illustrated more thoroughly in Part 4, under Dough Making.)

There are some certain rules which govern the acidity during fermentation. For instance, if you add one more pound yeast than usual to a five hundred pound dough, you can thereby either shorten the fermentation period at the usual temperature, or make the dough cooler giving it the usual time. It is the length of time the sponge or dough is allowed to stand, that causes most sour bread. (More facts about this are found in Dough Making, Part 4.)

Lactic fermentation can be carried on to some extent at the same time or together with the alcoholic fermentation in the same dough.

In my opinion that pleasant "nutty" flavor in white bread is created by one specie of *"Lactic" bacillus,* in conjunction with certain acid ferments (enzymes) contained in the flour.

This particular flavor-producing specie of lactic bacillus is always present in every dough, more or less, being brought into existence by some of the chemical changes of starch into sugar, the condition or quality on which the sugar supports or feeds this specie of lactic bacillus. This further strengthens my firm belief that the germs and ferments or enzymes, which produce and cause that "nutty" flavor in a loaf of bread are contained in the flour or rather in its carbohydrates—sugar and starch,—and it is up to the baker to know how to regulate his fermentation to suit the flour he uses, so as to get the proper or the best food for these flavor producing organisms. Of course, good healthy yeast must be used, and milk helps the flavor, so do other yeast foods like Malt Extracts, especially if the flour is lacking in quality.

But remember we have several species of closely related acid germs. When allowed to grow undisturbed, it is principally lactic and butyric acid which

causes dough or bread to get sour, more so than the acetic acid. (See Dough Making. Part 4.)

We will have to come back to the same subject in Part 4, but I want to call attention here to my opinion that although all authorities on bread fermentation state, that the total acid in sour bread consists of from 85 to 95 percent of lactic acid, the rest being acetic and butyric acid, you can not raise any dough with lactic fermentation alone. If it is as I suppose a lactic bacillus, which gives the "nutty" flavor, which the baker wants, then we must watch its development. If lactic fermentation is allowed to develop too fast, the lactic acid will get the best of it; it will get slimy and encourage butyric or putrefactive fermentation and increase the sharpness or sourness of the acetic acid. in short, cause "sour bread" by killing off all other ferments.

It has been estimated that there may be no more than four to five parts of lactic acid in 10,000 parts of baked bread. Of course, bread made with ferments or barms, like the scotch bakers use, contains more than this proportion and is sharper to the palate. Let me quote here the conclusion of Mr. James Scott: "It might be thought by some people that such comparatively small quantities of acid would hardly affect the bread, and that its sourness could be traced to acetic acid; but it is a curious fact that, as purposely staled bread reveals a gradually increasing quantity of it, the lactic acid really has the largest share in the transactions. There may often be quite 85 to 90 percent by weight of lactic acid in sour bread, while the acetic acid may be as low as from 5 to 6 percent and the butyric acid still less. Yet lactic acid does not smell, whereas acetic acid has a very pungent scent which can be distinguished in the fluid squeezed from sour bread."

Lactic fermentation develops or thrives best in a temperature between 82 and 95 degrees. When the

temperature of any dough or sponge passes 85 degrees, then look out for fast development of acetic acid or acetic fermentation.

Acetic fermentation. Acetic acid has been treated in Part I, under acids and also referred to in lactic fermentation. In my opinion, the acetic acid is not as dangerous in turning dough sour as lactic acid is. In fact, I think when yeast gets weak and less alcohol is produced (like in an old sponge dough) it is the acetic acid which stimulates the fermentation and causes a larger expansion of the loaf. As stated above however, while a proper percentage of acetic acid ferment will increase the ultimate expansion of the finished loaf, we must guard against an excess amount, because as we allow the acetic acid ferment to develop, the lactic acid will also increase but in larger proportions and sour bread will be the result. It has been proven, that in a fresh dough about ready for baking, the acetic acid percentage is larger in proportion to lactic acid than at any time afterwards. In some old doughs acetic acid may be found to have remained stationary for 24 hours, while lactic acid has increased materially. It may be well to remember also, that lactic acid does not, weight for weight, correspond with the same acidity of acetic acid. Three parts by weight of lactic acid have the same acidity as two parts by weight of acetic acid.

BUTYRUS fermentation. From above descriptions we find the "butyric" acid fermentation follows closely after lactic fermentation, especially when temperature in dough is allowed to go above 90 degrees F. Therefore, to discourage the fermentation of butyric acid, the process of fermentation must be carried on with lower temperature, say between 80 and 85 degrees F.

But when fermentation is carried on at too low a temperature say below 80 degrees, we have to increase the usual amount of yeast, at least one ounce for every

extra gallon water used and decrease the salt a half ounce at the same time; in this way, we get a whiter loaf of bread and a good texture but can not get the same flavor as in a dough made at 81 to 84 degrees. (See Dough Making.) If a dough is mixed and fermented below 80 degrees we must look out for such wild ferments or bacteria characteristic to low fermentation, encouraged by retarded yeast growth, which in turn produces small amount of alcohol and consequently the evolution of carbon dioxide is too weak.

In figure 1, I give an illustration of two loaves of bread, both standard loaves, each taken at random from a thousand-loaf batch. Loaf A has a very fine texture, a fine white crumb and thin crust. However,

A B

FIG. 1.—A, cool dough, made at 80° B, warm dough, made at 84°

crust is rather tough and rubbery and of a foxy, reddish color and the flavor lacks that something which makes people "eat more" bread. Ice is used in mixing to keep the temperature down below or at 80 degrees, as dough must be mixed longer or better than usual to stretch and develop the gluten. Loaf B shows a darker, creamy color of crumb, and texture is not so close. Crust is also heavier and a darker brown but more brittle and tender than in loaf A. The flavor of loaf B, however, is decidedly more satisfying, "home-made" like, and although to a baker loaf A may appeal better as to general appearance, the average consumer will eat more slices of loaf B than of loaf A.

Now as indicated before, the principal difference between the two loaves lies in the temperature at which the dough is fermented. In loaf A, more yeast and less salt is used to stimulate fermentation at a lower temperature. In loaf B, less yeast and more salt is used to prevent fermentation from proceeding too rapidly. All other ingredients, flour, sugar, yeast-food, shortening, etc., are the same. Hence I say again the baker who knows his business can make bread of different texture, color and flavor out of same flour.

Some chemists have carried on extensive experiments in adding certain acids in addition to the yeast in mixing bread dough, and if I recollect right some such process has been patented. Now I think there are sufficient acid bodies and acid producing ferments and enzymes in any good flour which together with good yeast, proper food (and a little brain on the baker's part) will make a good loaf of bread without any artificial acids or drugs.

SUMMARY ON FERMENTATION OR RAISING BREAD.

Bread is always raised by some process for the evolution of *carbonic acid gas* (carbon dioxide) (CO_2).

The process of creating and liberating this gas within the substance of a dough may be carried on by four different methods.

1. Chemical combination between carbonate of soda and some acid—cream of tartar, tartaric, phosphoric acid or muriatic acid. The first three are constituents of baking powders, and effervesce, (foam up) when wetted. The principal products of the above chemicai actions are, tartaric, phosphate and chloride of sodium (common salt) with of course the carbonic acid gas, the latter being the product wanted.

2. Chemical decomposition on heating. Carbonate of ammonia at about 150 degrees (F), releases over 50 percent of carbonic acid gas. Bicarbonate of soda is so decomposed into carbonic acid gas and carbonate of soda. (See Part I, Acids, Bases and Salts.)

3. The effervescence of aerated water (water in which carbonic acid has been dissolved by compression). Thus ordinary soda water may be mixed with some flour into a dough under pressure. As soon as the pressure is removed the gas is liberated from solution, and the dough expands. This is called aerated bread.

4. By Fermentation. This simply depends on the multiplication and products of bacteria or microbes. As already explained (Fermentation Part 2), these organisms feed on oxygen and carbon extracted from the carbohydrates or sugars, which are always present in dough, and they exhale carbon dioxide or carbonic acid gas as the waste product of their life-sustaining processes. Temperature, as we have learned, has a great deal to do with the condition or nature of fermentation.

WATER.

The importance of water in fermentation is frequently overlooked by the baker. Water was considered an element even by the most famous chemists, up to the end of the 18th century, when experiments first proved it to be a compound of Hydrogen and Oxygen. In Part 1. (Elements and Compounds) we learned that the chemical composition of water is H_2O:

By volume = two parts hydrogen and one part oxygen.

By weight = one part hydrogen and eight parts oxygen.

On account of its remarkable solvent power, water is never found pure in nature. This means that many solid substances, most any liquid and many gases are absorbed or dissolved when they are put in water.

Even rain or snow water which are considered the purest of natural waters, contain dust, gases, etc., washed down from the air. These are called natural *"Soft"* water, because they contain little or no calcium or magnesium salts.

HARD Water contains carbonates and sulphates of calcium (lime) or carbonates and sulphates of magnesium in solution. The hardness, due to the presence of carbonates is removed by boiling the water, hence the term "temporary" hardness. But where calcium or magnesium are present in the water as sulphate or chloride, these salts are not precipitated or affected to any extent by boiling, and the hardness, due to their presence, is spoken of as "permanent" hardness. It is also claimed that boiling will remove most any objectionable bacteria that may be present in the water. But boiling or distilling gives water a "flat" taste, because it removes the gases originally taken in from the atmosphere, which give the drinking water that freshness and pleasing flavor. We may say that any water which upon analysis is pronounced harmless as a drinking water is also satisfactory for use in the bakery. From a sanitary standpoint this is very true. However, from the practical standpoint the baker must look at it different.

The filtered water supplied by different cities, varies to a great extent. Some cities draw their supplies from natural springs and brooks; others have to get water from muddy, sluggish, poluted rivers, and many communities can pump their supply from fresh water lakes. Naturally different methods are applied to make the water clear and fit to drink, and in many localities some chemicals have to be employed. The passage of water, containing considerable atmospheric oxygen and carbonic acid, through iron pipes is apt to cause the solution of enough of the metal as "ferrous" or iron carbonate, to cause tea steeped with that water to be blackened, cloths washed with it to be stained yellow

and sometimes a peculiar taste to be produced. We also know that some water, especially very soft water, containing much dissolved oxygen or organic acids attack lead pipes very materially. How can the baker say then, that all water looks alike to him?

Most hard waters dissolve less of the proteins of the flour on account of the mineral salts they contain in solution as mentioned above. A dough mixed with such hard water usually gets tougher during mixing and tightens up more during fermentation; but the fermentation will proceed slower and the dough will stand a longer time before it is ripe. The crumb is usually very white, but coarse to the touch and dry to the taste. I know quite a number of bakeries, especially in the middle west, in the natural gas belt, who drove wells on their premises from which their water supply is pumped. Such water usually contains a great deal of sulphur or magnesia salts, making it especially well adapted for cracker baking. It makes a crisp, very white, but dry cracker. If you want such crackers tender, you will have to use more shortening than with softer water or add some gelatinized (cooked) starch. Now we might draw our conclusions this way:

"Hard water produces about the same results in comparison with soft water, as hard spring wheat flour does when used in place of soft winter wheat flour." Therefore the baker should take into consideration the quality or chemical property of his water supply when buying or blending flour.

I have often heard flour men say they could never understand why they cannot get a hold with their flour in one city or convince some baker of its merits, while in another place they sell every baker and grocer in town. I almost feel inclined to suggest to millers having trouble of this kind to get a sample of the water the complaining baker is using and have it analyzed. If water is hard, and you have a strong hard flour,

more yeast or a higher temperature for the dough may be of advantage, or you may blend such flour with some softer or some winter wheat flour or even more malt extract may give better results. Limewater is also recommended as a solvent, especially in rye dough.

YEAST FOODS.

The question of how to improve his bread is one that interests every progressive baker. In times gone by when every baker made his own yeast, stock yeast, barm yeast, potato yeast, etc., there was without question more individuality in bakers' bread, especially as to flavor. Some bread tasted better to some people than all the other bakers' bread; some was nearly always good; some was occasionally good; but a great deal was oftener tainted with a suggestion to being sour. We admit that bakers' bread today lacks variety of flavor and is very much alike in everything but the name, of which there are legions; but it is a fact on the other hand, that there is not so much poor bread or sour bread turned out by the bakers in these days of compressed yeast, as there was in the days of the home-brewed yeast. We also cannot get the men to stay up sixteen or eighteen hours to watch the yeast and sponge, as in years gone by, and the boss himself does not want to take a nap and get up again to watch the yeast, start the ferment or set the sponge, and then lay down again for a few hours. The flour and water bread with a little yeast and salt thrown in does not exactly suit the public any more, as a commercial loaf eaten at every meal. This is especially true of the American-born bread eater. Therefore the baker is always looking for a bread improver and the best food for his yeast.

CARBOHYDRATES are mentioned in Part 1, under compounds. The different sugars, dextrine, glucose, etc., are called soluable carbohydrates, while the raw starch in the flour is an insoluable carbohydrate

and must first be converted into sugar or glucose. They may therefore practically be classed with yeast food. (See Part 3 for further details.)

SUGAR. When we speak of sugar in general we mean cane sugar or perhaps beet sugar. I prefer the flavor of the cane sugar for use in bread dough. I think the New Orleans or raw, unrefined or clarified sugar is preferable; even the New Orleans seconds, if not too dark contain a good amount of sucrose and a rich flavor.

With sugar it is as with flour. There are a number of grades, according to the amount of boiling and the quality and color varies also from the different plantations. Color does not always indicate the quality and there is the old style open kettle process and the clarified or centrifugal. The juice from the sugar cane is boiled down and clarified at the plantation down south before it is shipped to the eastern refineries to be reboiled and refined. The plantation granulated sugar varies from 94 to 98 degrees sucrose-test. The N. O. seconds run in color from light gray to dark brown and in test for sucrose from 85 to 94 degrees. N. O. thirds are too heavy and dark for use in bread-making, but they do for mince meat and fruitcake but most of it is used in tobacco.

If I have to use refined sugar in bread dough, I find a soft Confectioners A or light colored C very satisfactory for fermentation and prefer them to the higher priced granulated. The eastern seconds or C sugars run in a number of shades from 1 to 14.

Beet sugars have no seconds or no soft sugars. After the granulated or loaf sugar is refined, the rest is sold as syrup. There are sugars found in other plants, especially the Indian corn or Maize, but are not as sweet as cane sugar.

Of course, in fermentation or dough making, cane sugar, especially the refined sugars, do not work so fast as a yeast food as malt or malt sugar or glucose.

GLUCOSE (grape sugar, dextrose, starch sugar) as mentioned in chemistry or fermentation, is found in a great many plants, grains and fruits, the latter being called fructose. The glucose of commerce can be manufactured from any substance containing starch —rice, wheat, corn or maize, potatoes, etc.,—but it is not nearly as sweet as sugar or malt extract. I remember some years ago, some of the larger bakers started to use glucose in bread making to take the place of sugar, but as far as I know, most of them have discarded the same, as unprofitable, although it was cheaper. The same with glycerine, which was much more expensive, but being much sweeter, so much less was required. But it did not prove a success. It is a characteristic of all yeast foods or sugars, that after the yeast has done its work, the baked loaf of bread contains much less sugar or sweetening than was originally put in the dough.

MALT is also considered an yeast food and has great powers on fermentation when properly prepared. Different grains such as barley, wheat, corn, rice and oats are capable of being malted. The word *malt* really means a grain which has entered into the primary or first stages of germination by artificial means and then being dried i. e. the germination checked. Experience has proved long ago that *barley* makes the best *malt* because it produces more diastase than any other cereal, and therefore *barley malt* has been used almost exclusively by brewers and distillers for hundreds of years and also by bakers in making their yeasts, barms and ferments.

MALT EXTRACT is an unfermented extraction made from Malt by adding a large quantity of water. The whole is then concentrated into syrup, the water being removed by evaporation at a low temperature. The quality of the finished Malt Extract depends principally on the care during this process, the proper process of germination or malting of the barley, the quality of the barley used, etc..

In cheaper extracts some corn or rice grains can be used, but I believe such Malt Extract has to be labeled as a compound which is proper. A small percentage of pure alcohol is mixed with the finished extract before it is gotten ready for shipment to increase its keeping quality, i. e. keep it from fermenting or souring.

The chemical composition and action of Malt Extract has been so freely explained and discussed in the *trade journals* and at conventions, that an exhaustive scientific treatise is hardly necessary. A good pure Malt Extract contains:

(a.) *Phosphatic Salts or Grain Phosphates,* which include the soluable Lacto, Phosphpates of different elements—as Potassium, Magnesium, Calcium, etc.

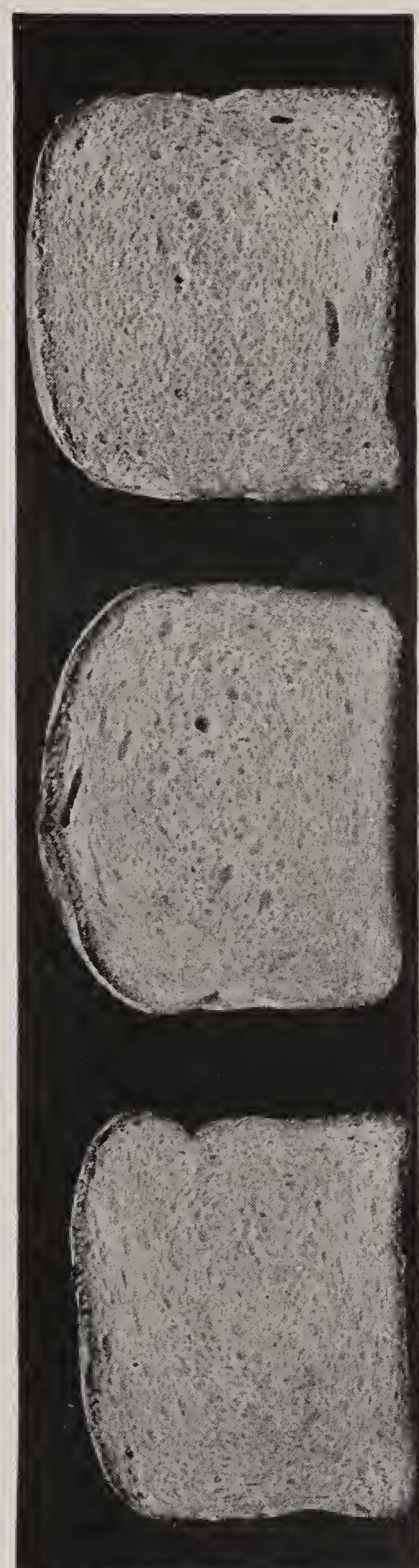
(b.) *Proteins or Nitrogenous Matter,* including principally digested Barley Gluten, and Digestive Enzymes=Diastase, Albumins, Peptones, etc.

(c.) *Carbohydrates or Malt Sugars,* which means digested Barley Starch, Maltose and Malto-Dextrine, etc.

(d.) *Moisture* which also includes the added alcohol.

Although a firm believer in Malt Extract since its first introduction and a constant user of large quantities of it, I have felt it my duty to determine or prove to our firm, whether the extra expense of buying Malt Extract is justified or if it is only a "luxury" a "notion", or a waste of money as some bakers declare it to be.

As with all other practical experiments, I based my conclusions on results obtained from our regular size doughs (about 1,000 loaves to each dough). In this instance I made three such doughs, each containing the same amount of materials such as salt, compressed yeast, water, flour and shortening (except sugar and malt.) Temperatures, conditions, amount of mixing,



A B C

FIG. 2.—A, Bread with Sugar alone. B, Bread with Ferment of Malt Extract and Sugar. C, Bread with Malt Extract alone.

etc. also were the same in each dough. The formula is one used in one of our leading pan loaves, made from straight dough. The illustration (Fig. 2.) on page 23 shows one loaf of each dough.

FIRST DOUGH A. was made with sugar only. I use New Orleans or clarified soft sugar (see sugar).

SECOND DOUGH B., in this dough I use my regular "quick ferment" made of malt extract, cornflour, yeast and water. (see fermentation.) But I used sugar besides the malt extracts in this dough.

THIRD DOUGH C., malt extract alone was used as an yeast food and sweetener.

IN DOUGH A., the usual amount of yeast and sugar and special cornflour was mixed with 18 lbs. of water at 90 degrees. After standing for nearly 10 minutes, the mixture did not show any signs of fermentation or expansion like regular ferment; (this however, I expected, judging from previous experiments.) I then added one pound more of yeast and two pounds more sugar and poured the whole mixture into the dough which was already running in the mixer as usual.

FOR DOUGH B., our usual ferment was made with 4 lbs. of malt extract, 6 lbs. of cornflour (special) 4 lbs. of yeast and 14 lbs. of water. This ferment was ready in the usual time (about 18 min; for particulars, see ferments.) It was then added at once to the dough already running in mixer. Besides this ferment, 12 lbs. of sugar had already been added to the dough, with the salt, shortening and water. The reason why I add the extra sugar in my straight doughs is explained in chapter on Fermentation.

IN DOUGH C, the same ferment was prepared as in Dough B, with the exception that I used the double amount of malt extract and no sugar in the dough. This ferment was ready or fell in two minutes less time than in Dough B.

These three doughs were made 25 minutes apart, which is the regular time we allow between each 1,000 loaf dough. Each dough is supposed to be ready for first knockdown in 3½ hours; second knockdown in 4¼ hours, and ready for bench or divider in 5 hours.

However, as I expected, the first dough A., stood 3 hours and 40 minutes or 10 minutes overtime before it was ready for first knockdown, although it had one pound extra yeast. Second knockdown also had to be waited with 15 minutes longer than usual.

Second dough B. came on regular time 3½ hours, 4¼ hours and was ready in five hours.

Third dough C. stood just about the regular time for first knockdown (3½ hours) but came quicker second time (4 hours) and had to be punched once more (4¾ hours).

The consequence was that the first dough A. was a little too young; the second dough B. was perfect and the third dough C. was already getting a little old. I could have taken dough C. first, dough B. next and dough A. last, and then I could have obtained about same kind of loaf from each dough. But as it was an experiment; the object was to note the results for comparison. In the proof-room the following time was required:

Dough	A.	These	loaves	stood	55	minutes.
"	B.	"	"	"	48	"
"	C.	"	"	"	45	"

This shows that the loaves from all three doughs were ready for the Oven at almost the same time, especially as the loaves made with Malt Extract alone (dough C) do not require to come up so high in the pans. In the ovens the bread from doughs B. and C. colored and baked a little quicker than the loaves from dough A. The illustration tells the story:

Loaf A. is rather close grained and solid, although the heavy crust indicates that it was thoroughly baked.

Color of crumb or inside is a clear, healthy white and flavor sweet and pleasant. Crust is a good, healthy golden brown.

Loaf B. has a very regular texture, almost perfect and a good, rich, clear, light creamy color. The crust is a little heavy but very tender, not a bit tough and of a rich brown color. The flavor is that pleasant, sweet, satisfying, "nutty" kind, frequently referred to as homemade.

Loaf C. is the largest loaf, but texture is not quite as good as B. and color of crumb not quite so white. This dough C. should be taken sooner, i. e.—kept younger. (Crumb means inside or soft part of loaf.) From my own experience I came to these conclusions on the merits of Malt Extract:

It stimulates fermentation.

It is an excellent yeast food and by providing or preparing proper food for the yeast, less yeast can be used.

It also gives bread a distinct, pleasing, rich flavor.

The crust of a malt loaf always has a rich, golden brown color, if dough is kept young enough.

But the most important point in favor of malt extract is, its power to reduce the amount of raw or unconverted starch in our bread and make it better digestible.

Malt Extract also helps to retain the bread moist or fresh for a longer time; the chemists call this the *hydroscopic power* or moisture retaining properties.

For large bakeries working with modern improvements and having the doughs under perfect control, I recommend a high diastasic Malt Extract, say 120 degrees Lintner. For a smaller bakery however, where the dough can not always be worked off at schedule time, I would recommend to be careful and not use too much malt extract or too strong an extract, as it

can do more harm than good, if allowed to work itself all out by prolonged fermentation, or especially if dough is made too warm.

The "Lintner" process for determining or testing the diastasic power or strength of Malt Extract, is used by the manufacturers of malt extract and chemists, and they offer or are able to prepare an extract of such test as:

140 degrees	120 degrees
90 degrees	60 degrees

or as low as 20 degrees. But as one degree Lintner represents such a small amount of diastasic action it sound bigger to speak of 120 degrees than of a 60 degree extract than what the difference really represents in actual strength. To make these Lintner tests is a rather complicated process, and it would be almost impossible for a baker to select or test different extracts, to find the proper degree extracts to suit the different kinds of dough. It takes an expert chemist or malt specialist to accurately make these tests.

As to the quantity of malt extract a baker should use, conditions such as water, temperature, altitude and strength of flour vary so, that no certain amount can be recommended to every baker. In general from 1½ to 2 pounds is sufficient to a barrel or say 200 pounds of flour if you want to use it with sugar; malt extract alone figure 3 to 4 pounds.

I have mentioned above that I prefer to use malt extract and sugar both in the same dough. My experience has been that in this way I get best results, and my reasoning is this: Malt extract works faster or more aggressive, especially a 120 degree extract on both the starch and gluten than sugar. Therefore, I use the malt ferment to start the work and provide ready food for the yeast, the sugar will be working slower and preserve more of its sweetness. Both used in same dough, work better than either malt or sugar alone. As there are now several responsible firms who

make a pure, uniform Malt Extract, the baker, large or small, should have no difficulty to get the right quality of Malt Extract if he is willing to pay the right price.

GROUND MALT, Malt Powder or Malt Flours made from selected barley make a very strong yeast food. The flavor is more of a distinct malt flavor, but even more care must be taken not to use too much of it. It does not start its work with the yeast as quick as liquid malt extract, but after it started to work once, the dough must be watched closely and punched down frequently. One advantage of using malt in dry form is, that it is easier to handle than liquid extract and will not turn sour. Of course, you do not want to allow dry malt to get stale, or damp or keep in too warm a place.

I used Malt Flour some twelve or more years ago, and got good results. In rich, sweet doughs, for coffee cakes, rolls and buns, wherever more sweetening substance is wanted, I find malt powder does good work. To use very large quantities of sugar, is liable to make the dough too rich, while malt furnishes a better yeast food and makes the dough lighter. Therefore I recommend to use malt as stimulant and sugar to sweeten the dough. One advantage is, that you can take such sweet rich doughs very young as the rolls, buns or coffee cakes will come along faster in the proof-room, and the expansion in the oven is remarkably good.

BREAD DISEASES.

What causes dough getting sour? As we all know, dough is more liable to turn sour in summer than in winter. We know further that uncleanliness of tools and vessels facilitates the souring of dough, but this does not solve the question. We must seek the cause elsewhere.

But it is not only bread dough which gets sour in the summer time, but almost all meat, yeast, milk, etc.,

will soon spoil if left openly or exposed to the air. Therefore, we most naturally must suspect "the atmosphere." But is it solely the heat? That can not be, because we try to keep the same temperature in the shop and dough room in winter, and even make the dough warmer. Now, since the heat of the shop does not (as the sun heat or atmospheric heat) facilitate souring of the dough, the cause must be in the chemical condition of the atmosphere. We have learned in Part I, that the air consists largely of oxygen, and this change in the atmosphere in summer time contains a larger proportion of oxygen or the oxydising faculty or chemical attraction of the same, becomes more active; especially before or during electrical disturbances or thunder storms, the air becomes heavy and sultry and milk curdles, the dough gets sour, if not watched closely. Lime-water kept in flat vessels in the bakeshop and dough room is a good preventative for this evil; so is an occasional washing of the troughs and tubs, water tanks, etc. with lime water and frequent white-washing of walls and ceilings to be recommended. These precautions have the effect of neutralizing the acids which may be present and render them harmless.

MOULDY FLOUR and mouldy bread are caused by certain species of moulds, somewhat allied to the mushroom, and like those formed on top of preserved fruits. The most common is the "blue green" mould; dampness in flour causes such mould and murky weather has the same effect on bread.

BUTYRIC FERMENTATION may also be classed with the bread diseases, because as soon as this strong acid gains any foothold in a dough, putrefaction (rottenness) is the result.

ROPE IN BREAD. The most dreaded bread disease is the so-called "Rope." Fortunately to say, I never had an opportunity to become personally acquainted with this dreaded "foe" of the bakeshop. I have seen loaves of bread infected with the disease and have met

bakers, half crazy and worried to death over it. But my opinion is, that the bacteria, microbes or organisms causing rope are present more or less in nearly every flour, or different grades of flour, and they may also be hanging around on the walls and ceiling of any shop or lurking in some crevises of your dough troughs and tubs for a long time perfectly harmless. They are just waiting for the proper condition or food to come within their reach to materialize, and behold, when once started, it is h—— to get rid of them. I agree with the *American Miller* who says in an editorial: "He contents himself with stating that rope is caused by a ferment, but whether it is the 'pediacoccus cercoisive' as Jago calls it, or the bacillus subtillus of Blandy, he evidently cares not, contenting himself with a study of the conditions under which 'rope' appears and how to avoid or neutralize these ferments."

German scientists claim that rope is caused by the potato bacillus *'bsc. meseutericus fuscus Flugge'* which are present in the flour. Now I compare this "rope" with the germ of contagious diseases. Disease germs are always present more or less in the human body, just waiting for the proper condition for infection and their development and multiplication. This theory is supported by the fact that certain diseases make their appearance in different seasons of the year and disappear in colder or warmer weather. The same with rope in bread. It is most prominent during the hot summer months, especially in a long damp, sultry hot spell. You hear little about it in winter.

PART 3.

Flour, Gluten, Chemical and Practical Tests.

FLOUR.

STANDARD OF FLOUR.

The establishing of a flour standard seems impossible. Few bakers seem to realize the difficulties the miller is up against. To get a supply of wheat to make exactly the same quality of flour from one crop to the next is a harder proposition than we bakers comprehend. The miller's raw material varies a great deal more than the baker's raw materials. Not only does the wheat from different sections of the country differ in quality and demand different treatment before it can be profitably milled, but the wheat growing in the same section, even on one farm frequently differs. The blending of this wheat and the dressing of it during the milling, to get a uniform run of flour is a science, the practice of which requires more care and experience than the average baker ever dreamed of.

To sell a baker flour three or six months ahead, guaranteeing a certain standard to be delivered at that time, is a pretty hard proposition. In fact, it is only the larger mills who can honestly guarantee their product so far ahead, as they alone have the means enabling them to ascertain the exact composition their product will have. This is accomplished by tests made in their experimental mills or their laboratories. But

one thing the baker can assure himself of is that the miller making a standard brand of flour can not afford to deliberately deceive him as to quality for any length of time. They all make good flour and none of it should be condemned as bad.

The main thing is, the baker must first study his method of working a flour and then pick out the one that is best adapted to this method. He can also change his method of working and give a flour a chance to show its best results. As business is now, the cracker man demands one kind of flour, the small baker another and the large baker still another. But the complaints the average miller or the miller's agent gets, come more frequently from the small baker than from any other source. The larger percent of high-priced flours are put out as short patents. The gluten in them is of a better quality than in the longer patents, even though there may not be as much of it. The better the quality of the gluten the shorter fermenting period is necessary or the less time the dough needs to stand.

Right here is where the trouble comes in. The average small baker makes a long time sponge or long time straight dough. These allow so much acid to develop that it weakens the gluten of good quality in a short patent, and causes a runny dough with poor raising power and often a dark, smaller loaf. But with a longer patent or straight, this method often gives fair results, especially if a baker has become used to handling a certain brand for any length of time.

By this you can readily see that it is up to the baker to choose, for a standard, the flour that is best adapted to his methods of working, or else change his methods to suit the flour—or, still another way is to blend. But one thing in particular to remember is, that the large mill with well advertised brands can not afford to give you bad goods, so in place of blaming it all on the flour, why not try and change your method and formula and you will get good results.

Then there are so many conditions affecting the different constituents of a flour after it leaves the mill, that the original laboratory test may be changed considerably before it is made into dough. Suppose the car is sidetracked somewhere on the road and left exposed to dampness and rain or snow. The flour will draw more or less of the dampness, especially if it is put in storage for a month or more afterwards. The consequence is, that such a flour will develop more acidity which has a weakening effect on the gluten, and when finally brought to the bakery it will not produce the same loaf of bread when given the same working method the baker used for the sample or the previous car; or a car of flour is exposed for several days to scorching sun rays, when it is 95 or over in the shade, and then the flour is stored for some time in a dark or badly ventilated warehouse. Such flour will not give the same test as the one taken and placed on record at the mill.

From my own particular experience after thirty-five years in the bakeshop, and being up against all kinds and qualities of flours (varying widely from year to year according to conditions of wheat crop) I have come to the conclusion that there is more good, reliable, uniform flour at the baker's disposal at the present, than ever before. If the baker is willing to pay the price, he can get the right quality of flour, and frequently one can get hold of an excellent or valuable flour from a smaller mill, at a low price; on account of their brand not being so well known, and their selling facilities being limited, they often accept a lower cash offer than the quality of their flour really would entitle them to.

I like to go on record with the statement, that in my opinion the time is not so far distant, when the baker will leave the blending entirely to the miller, and many a wise baker is doing so today. All that is necessary, is the confidence in a square deal, and the taking in consideration of unforseen circumstances,

which may affect the flour, after it leaves the mill, as mentioned above. Of course different kinds of bread require different grades of flour, as described further on, under Blending and Dough Making.

Every baker should keep a note book for records of all tests of flours, marking down dates receiving flour, date of test, brand, percent of gluten, its quality and color, absorption, color and character of each flour, etc.

DISTINCTION IN FLOUR.

Grades of Flour. In general, wheat flour may be classified as follows:

1. Flour obtained from center of grain and ground more or less fine (fine flours).

2. Flour milled from other part of grain as well as part of center, not so finely ground (fine sharps, seconds, etc.)

3. Flour obtained from the entire grain (whole-meal flour, graham).

The main differences between these flours exist in the amount of nitrogenous matter, and salts which each contains. As we change from the finer flours to whole meal, we notice that the nitrogenous particles or proteins and mineral matter increase and the carbohydrates, starch, sugar, etc., decrease in percentage. Now we know that part of the nitrogenous matter and also a small proportion of the carbohydrates are soluble in water. But during the process of cooking the soluble albuminoids are coagulated and thereby rendered quite insoluble, while insoluble carbohydrates like starch are rendered into more soluble forms.

It is quite sufficient for the baker to recognize five grades of wheat flour.

1. First Patent (60 to 65%).
2. Second Patent (65 to 70%).
3. Straight (70 to 85%).
4. First Clear (80 to 90%).
5. Low grade Red Dog (90 to 95%).

The germ which would be included in the first Patent, is always separated from the other constituents of the grain.

DIFFERENT GRADES OF FLOUR.

The most simple explanation how the different grades of flour are accounted for, was given by Mr. H. S. Helm, at the Mineapolis Bakers' Convention. To give us all a chance to memorize these names, I quote Mr. Helm's remarks: "There are four sources during the milling process which account for all the flour from the wheat viz: the *Break* flours, the *Middling* flours, the *Tailings* flours, and the *Dust Collector* flours. Each of the thirty to forty streams of finished flour comes from one of these four sources. The purified Middlings flours, comprising from 60 to 70 percent of all the flour product are always run together and make up what is called a *pure middlings* patent, the highest grade of flour made. When running a pure middlings patent, the break flours, tailings flours and dust collector flours, aside from a small portion of low grade, are run together for a grade called first clear. All grades of flour between middlings patent and first clear are some combination of the two. Therefore, in discussing the working properties of bread making flours, we may designate them either as middlings patents, long patents or first clears."

Flour Bleaching. The yellow or dark coloring matter in flour is minute in quantity and has no food value. It is claimed by competent chemists, that the minute quantity of bleaching gases used for bleaching flour have the power of changing this coloring matter in such a way as to make it appear colorless, but does not introduce any injurious substance into the flour. It has even been claimed that some flours are improved in quality by drying it out by the bleaching process, and by thus aging it, it produces more loaves of bread and a larger loaf. However, I prefer to see nature do the bleaching in its natural way. Furthermore, the

baker would always be at the mercy of the miller unless he tested every shipment of flour or had an analysis made, because the color could deceive him very easily. Although by bleaching different grades of flour they may hold their relative position or composition in every other respect, as before the bleaching process is applied, there is always room for mis-representation of grade. Some second patents or straights from one mill may be as good (and sometimes are) as the first patent from another mill, and the baker may be willing to pay a better price for such second Patent or Straight than he would ordinarily pay; but if the miller knows this fact it is more than likely that he would apply the bleaching process and sell it to the baker at a more fancy price. Now the baker buying this flour at its natural stage at the grade price, can blend it with a white fancy Winter or first Spring patent and save the premium otherwise added by the miller. Therefore, bakers are safer since the bleaching of flour has been prohibited.

If bleaching is a benefit to flour, commercial loyalty or honesty demands that the buyer should be informed whether any chemical or physical process has been applied.

Flour Blending. Now there is not so much danger of chemical changes affecting the flour or quality in general from blending if flours are about of same age, as there is in blending flours of different age; for instance one flour just from the mill fresh ground, and another flour which was kept in warehouse for several weeks or months.

I can not see as much benefit in mixing flour of last crop with flour of new crop, either, as most bakers imagine. It is better to adjust your working methods or fermentation to the condition of the flour on hand. Of course you get less volume out of a fresh ground new wheat, and new flour may not be as strong in gluten as that from previous crop. Therefore, it is well to have some flour from last crop in reserve to

use as a blend until the new flour is seasoned and its working character established.

Kansas flour makes a good blend with hard Northern or Minnesota Spring Patent. I like a rich, short, 60 percent Kansas Middling Patent for this purpose. It gives a good color to the loaf and good texture, and good flavor.

Then an addition of say 10 to 15 percent of soft winter straight makes a rich blend of good flavor, and enables you to cut down sugar and shortening.

Any well known brand of Minnesota Spring Patent may be used as Standard in the laboratories. It is not conclusive, however, that the same brand of Spring Patent is or can be used every year as standard for comparison in chemical analysis with all other flours. The most uniform and best balanced in every respect is selected after new crop wheat has matured. I, myself, have had occasion to change the standard for three successive years, and then again I have adopted one brand for three years in succession for my standard flour. As mentioned before, it is not only very instructive, but also of real cash value to any baker to preserve these records from year to year for comparison.

COMPOSITION OF FLOUR.

Moisture in Flour. The moisture or water contained in fresh milled flours varies very little. Even the different grades do not vary to any great extent; the highest percent seldom exceeds 15 percent, the lowest being less than 9.50 percent. The percentage of moisture or water as standard for a good bread flour may be set down at 12.00 percent. Most of this water is found in the starch or carbohydrates. These being very susceptible to taking up moisture, (hydroscopic power) flour is very liable to take up moisture when exposed to damp, moist air. However, this is detrimental to the baking quality of flour, as an excess of water causes chemical changes in the flour, the acidity

increases and softens the gluten (gliadin), and more or less dextrin and maltose will be produced by diastasic enzymes. Also moulds are encouraged by excessive moisture in flour.

When exposed to dry air, sun rays, and heat, flour loses moisture. This has more effect on the fat (ether extract) and color of flour; it bleaches out and loses in flavor also due to chemical changes. However, as to the money value of the loss to the baker, that is evened up by the larger absorption of water in dry flour. If flour loses 1½ to 3 percent or an average of 2 pounds per barrel in transit or storage, it surely will take up that amount or more extra water in dough making.

The miller is the one who has to pay more attention to the moisture in the wheat, as the soundness of wheat is greatly affected by too much water, also much skill and care is required during the process of milling, to have the finished flour contain the proper amount of moisture, without affecting the different constituents of the flour.

Absorption. As we all know, different flours absorb, or take up, more or less water. The difference may be 15 percent, or in other words a barrel of flour may absorb from 100 to 135 pounds of water. The extra water may be credited as nearly so many pounds of bread, allowing a trifle extra expense for salt, yeast, sugar, etc. Two flours may be nearly alike in general composition, but differ greatly in the amount of water they can carry. I say carry, because some flour, (especially cheaper grades) may take up more water in mixing, but the dough slackens up and gets sweaty and sticky afterwards. Some flour men lay great stress on the absorption power of their flour; some are regular "water eaters," "hungry as wolves," for water; but as I have mentioned the relation of absorption to other qualities in the different chapters, it needs no further comment. All I say, if a baker gets 60 percent water into his dough for every pound of

wheat flour used, he ought to be satisfied. I say pound of wheat flour because we can add a mush or prepared corn flour, maize flakes, etc., which take more water, up to 200 percent. Any excess amount over 60 percent will either evaporate in baking or requires extra yeast, yeast-food, fat, etc. Of course as will be shown later on, the process of developing the gluten during mixing process, increases water absorption and gives whiter color.

Strong Flours need a longer fermentation with straight dough method, as short fermentation with strong flour produce tough, dry bread with irregular, coarse texture and occasionally large holes.

Some flours, especially short Patents, are misleading in absorption of water as they dough up rather soft first, but tighten up either during mixing or during fermenting stages of the dough.

You can judge by doughing up a sample of flour if dough will be firm and elastic or slacken up and ferment wet and sticky. Work the sample well with your hands and break frequently with a quick snap. Then let rest for ten minutes under cover and repeat working again. Make note of your observation.

PROTEINS. The total protein content of different kinds of flour shown by analysis, varies more than any other item, but in the various brands of the same grade of flour from different mills the difference is very slight, nowadays. The proteins in a wheat kernel (and in flour) are best classified as follows:

1. An albumin, which is soluble in water and coagulable by heat.
2. A globulin, which is soluble in salt solution, also coagulates in heat.
3. A proteose body, soluble in water, but not coagulated by heat.
4. Gliadin soluble in dilute alcohol (of 70 percent).
5. Glutenin, which is not soluble in either water, salt solutions or alcohol, but softened and partly dissolved by certain acids.

These bodies are present in average bread flour about as follows:

Albumin	0.3%
Globulin	.9%
Proteose Body	.2%
Gliadin	6.8%
Glutenin	4.0%
Total	12.2%

It will be seen from this table that the gluten (consisting of gliadin and glutenin) forms nearly the whole protein content of the flour. The other protein bodies are of little practical interest to the baker. For instance, when we mix a spring wheat flour with a soft winter wheat flour, we are mixing two glutens of a different character or in a different condition for peptonization; they will act and react to some extent on each other. This applies also when we blend different grades of spring wheat flour.

COLOR OF FLOUR.

The usual method of testing color of flour is to place a small amount of the flour on a glass tile or smooth board. Smooth it down solid with a "slicker," cut off three sides which leaves a rectangular, smooth body. Now prepare a similar sample of your standard flour; push the two close together, side by side, and with one firm stroke of the slicker, smooth them both at the same time. If there is any difference in the colors it will be readily noticed in the line between the samples. But any difference in color can be noticed much plainer by plunging the slab with the samples into a basin of water. As the flour dries, the more marked will be difference in the color. It is advisable to keep a sample of a standard unbleached spring Patent flour on hand for the purpose. Keep it in a bag in a dry, airy place, but not exposed to direct sunlight.

Another good simple test for color a flour will produce in bread dough, is made like this: Dough up a

small amount of flour, not too stiff (or use a piece of same dough made for gluten test as described in "Practical Flour Tests,") and place it on a piece of clear, colorless glass, and flatten it down some. After standing for about 24 hours, turn it over, and examine the bottom of the dough through the glass. Thus you get a good test of the exact color of the flour. I understand this test has been used by officers of the commissary department in charge of the purchase of flour for the army.

My own way to determine color has been described in "Practical Flour Tests."

FAT CONTENTS OF FLOUR.

What the chemist calls the "Ether Extract" in flour is mostly natural fat or oil. The relative quantity of extract which is obtained from a flour depends almost entirely upon the degree of perfection with which the grain is freed from its germ in middlings. Where some of the germ is left in the flour, the percent of ether extract will be high; where the germs are almost completely removed the ether extract or fat will be low. Wheat flour contains an average of 1.02 percent of fatty matter or ether extract; Rye flour as much as 2 percent. The fat is extracted from flour by mixing one part of the flour (say one ounce) with four parts of ether and four parts of pure alcohol and shaking well. It is then heated in a tube to 104 degrees F. and the fat will be seen separating and coming to the top in little globules.

ACIDS IN FLOUR.

Although the acidity of a flour can be ascertained in a chemical way by titrating with an alkali solution (as explained later on), I depend more on my practical test (Plate II, page 33). By repeated practice any practical baker can become quite efficient to judge the acidity of a flour by this simple method. There is still another valuable advantage in these doughing tests

for determining the character of the acid ferments contained in a flour. When you break the pieces of dough after standing about 24 hours you will be surprised by the difference of the odor of the interior of each piece. Some retain a rather sweet, pleasant flavor while others have a more or less pungent, sour smell, some even may be called rotten (putrefactive). After gaining some practice through repeating these tests regularly with different flours, you can form a very fair judgment not only as to the acid in the flour, but as to the relation of the ash content as to color and acidity in large doughs. The percentage of acid gradually increases as the grade of flour decreases and we may say acidity goes up or down with the percentage of ash in a flour, the lowest grades containing most and the highest the least.

Acidity of Flours and Doughs. Prof. H. C. Harrison summed up the acidity as follows:

1. Flours from different localities show a wide variation in their acid and bacterial content.

2. The alkaline test indicates a rapid development of acid in 3 to 5-hour doughs.

3. Weak flours test higher in acidity than stronger flours.

4. Flours yielding a good quality of gluten have a lower acid content than those with an inferior quality of gluten.

5. Graham flours test highest of all in acid. Next in order are "low grades," "straight" and "patents."

6. Numbers of bacteria are not in the same ratio as the amount of acid found in flours and doughs.

7. No colonies of the lactic acid bacillus were found.

8. The commonest organism present in practically all the samples was an organism producing a yellow color which had an acid reaction when grown in sterile milk and curdled it.

9. The bacteria in stale flours were chiefly putrefactive forms and most of them formed spores.

10. Hard wheat flours and "patents" contained comparatively few bacteria. "Graham," "low grade" and "soft" wheat flours, on the other hand, contained very large numbers of both bacteria and molds.

Acid Tests of Flour, Sponge, Doughs, Etc. Flour does not readily give up its acids to solvents. To determine the acidity of a flour the chemists use this method: 10 grams of the flour and 200 c. c. of distilled water are placed in a bottle and shaken well and repeatedly. After about one hour the solution is filtered, and 50 c. c. of it is titrated with a tenth normal solution of pottassium-hydrate, using phenolphthalein as an indicator. This is done as follows:

Pour 50 c. c. of the flour solution in a glass (very clean) and add 3 drops of phenolphthalein and stir with glass rod. Then fill a burette with above solution of potassium hydrate to a certain mark, say, 50 c. c., so you can read the amount used correctly. Drop some of the normal solution from the burette into the glass containing the flour solution, stirring it continually, adding a few drops at a time from the burette. As soon as the solution in the glass turns pink, the reaction is complete, and you calculate the acidity from number of c. c. (cubic centimeters) of the standard solution in the burette used to turn the flour (or sponge or dough) solution pink. This is called "Titration."

ASH CONTENT IN FLOUR.

There has been considerable said and written about the ash content of flours. Some bakers buy their flour on the ash content test, furnished by a laboratory, but if I was a miller, I would never sell to a baker on such agreement. Now while a low percentage of ash indicates a short Patent, or so-called first or fancy Patent, and a

larger percent of ash is supposed to identify the flours as a second or long Patent, yet a longer Patent from one mill may be almost identically the same grade or have the same value to the baker as a shorter or first Patent from another mill.

Low ash must correspond with other qualities of a flour, such as gluten, color, etc. The quantity of ash recovered from a sample of flour is so small, that the slightest oversight by the chemist or his assistant, who generally makes these tests, renders the test unreliable. Another weak point is, that chemists do not all make their ash determinations under absolutely identical conditions.

You may get a widely different ash result on the same flour if submitted to different chemists, due to very slight differences in the methods of analysis employed. However, in a good first or fancy Spring Patent, the ash is expected to amount from forty to forty-eight hundredths (0.40 to 0.48) average 0.44 percent; in second Patents 0.48 to 0.65, and then in straight, clear and whole wheat flours up to 0.84 and to 1.80 percent respectively.

The ash bears a very close relation to the color of a flour. The higher the ash content, the lower, or poorer, the color.

GLUTEN.

What is Gluten?

Gluten has commanded more attention and discussion in bakers' trade journals and at conventions than any other substance, connected with flour or bread making. It has been called the "backbone of cereals;" the "lean meat of the vegetable kingdom," the "Prince of Proteins," etc. As a fact it stands related to the vegetable kingdom as does albumin to the animal kingdom. However, in no other cereal or plant is the gluten so prominent or important, as in the wheat and the flour made therefrom."

But, it will be shown in this chapter that the quantity or percentage of total gluten in a flour is not of as great an importance to the baker, as most flour salesmen have tried to make him believe. However, most flour men are getting wise to the fact, that there are more bakers interested in the *baking quality* of gluten, than in the quantity of same.

GLUTEN is composed of two substances—*Gliadin* and *Glutenin.* These two parts are quite different in character, but when wet, both cling together and form the gluten.

Glutenin is more granular and tough and rubbery, and of a gray dead color.

Gliadin is more sticky, and acts like glue in binding together the particles of the glutenin and is of a creamy or greenish color. The proper composition which makes the best gluten (viz.—that which gives the most expansion and best color in bread) is 60 to 65% gliadin and 35 to 40% glutenin. In the flour from soft or winter wheats the average ratio is 70 and 30% Bread made from flour deficient in gliadin has poor expansion powers; but when the percentage of gliadin is in excess, the dough will relax, get softer and sticky during fermentation.

If the total gluten amount in a flour is smaller, but its character or quality is good, the bread baked from such flour may be as good or better than that from a flour containing more gluten.

If the total gluten amount in a flour is excessively large, it does not follow that the bread made from it is lighter, larger or better; rather the reverse. The quality of the gluten which gives it its high value in bread making is found principally in its ability to entangle and hold the gas. (See Fermentation.)

EXTRACTING GLUTEN. Weigh 50 grams of flour into a cup and mix with 27 grams of water. This will make a medium stiff dough. Weigh off 50 grams of this dough and set aside in a cup of water

for 20 to 30 minutes. Then start working it in a basin of cool water between the fingers of both hands. The starch separates from the dough and by repeated washings with fresh water, all the gluten is finally obtained, as a rubber-like mass. Keep on working and rolling it in your hands and pulling it, drying your hands frequently on a towel to get all the moistures out of it.

Some bakers wash the gluten under a light stream of running water, keeping on until the water runs off clear; but it is advisable to have a sieve below your faucet lined with silk bolting cloth (about No. 16) to catch any particles of gluten, which may break off during washing.

For beginners it is advisable to fold up a piece of bolting cloth (not too fine) or muslin into a little bag, put the piece of dough inside and start washing as above, by squeezing the dough continually. This method is the only one you can use in washing out gluten from a piece of fermented sponge or dough, as you must use water below 45 degrees, or even ice water, because the glutenin has been softened so much and gliadin in old sponges is about all gone during fermentation. In fact water should never be warmer than 65 degrees for washing out glutens, unless the gluten is very tough and strong, as in the "straight" flour when it may be 70 degrees.

For washing out just flour samples doughed up, the water should not be too cold either, otherwise you chill the gluten and it gets stringy. Here is where many bakers and millers and even chemists make a mistake, as they do not regulate the temperature of the water according to the quality or strength of the gluten. You try this yourself. Start washing with properly tempered water, then change into a warm or even tepid water, and in a few seconds you will feel the gluten break up into little strings and curdles, and you never recover it again. Then wash another piece in water of 65 degrees until you have part of the starch removed,

when you take it into water of 38 or 40 degrees, so you can hardly keep your hand in it. You will notice the gluten shrivel up like a piece of rope or in strings, and unless you put it back into a warmer water you can not get it smooth and to hold together.

Now, after you have all the gluten you possibly can exact by washing it carefully, form it into a solid little ball and weigh accurately. Then place it on a piece of strong tough paper (about 2 inches square) and put away until you have the other samples ready, when you bake them on a strong level pan. I get best results when baking gluten in an oven filled with bread, or at least at same temperature as bread. Before baking it take notice of color and firmness of gluten and keep record of same.

For other characteristics and effect of color of wet gluten on the quality also see "Practical Flour Tests."

EXPANSION TEST OF GLUTEN. An apparatus to test the expansive power of gluten has been invented by Mr. C. M. Foster. The accompanying illustration of this gluten "tester" will be of interest to bakers who are not acquainted with it. It is made of metal, consists of two cylinders of like diameter, each 8 inches long. One gluten sample is placed in each cylinder, the same fitted on the little bowl and the piston inserted with a certain weight on top of it. The pistons are then fastened down by pressing down the lever as shown in illustration, and the apparatus is ready to go into the oven. The chemists generally have a small electric oven, but I get best results by placing it in one of our regular bread ovens; I even prefer to have it in with an oven full of bread, as this is the right temperature. The moisture in the washed gluten as it becomes heated, is converted into steam, expands the gluten and forces up the pistons. Gluten of the greatest elasticity will force the piston highest, making it possible to obtain a record in inches of expansion of glutens from like quantities of different flours. I

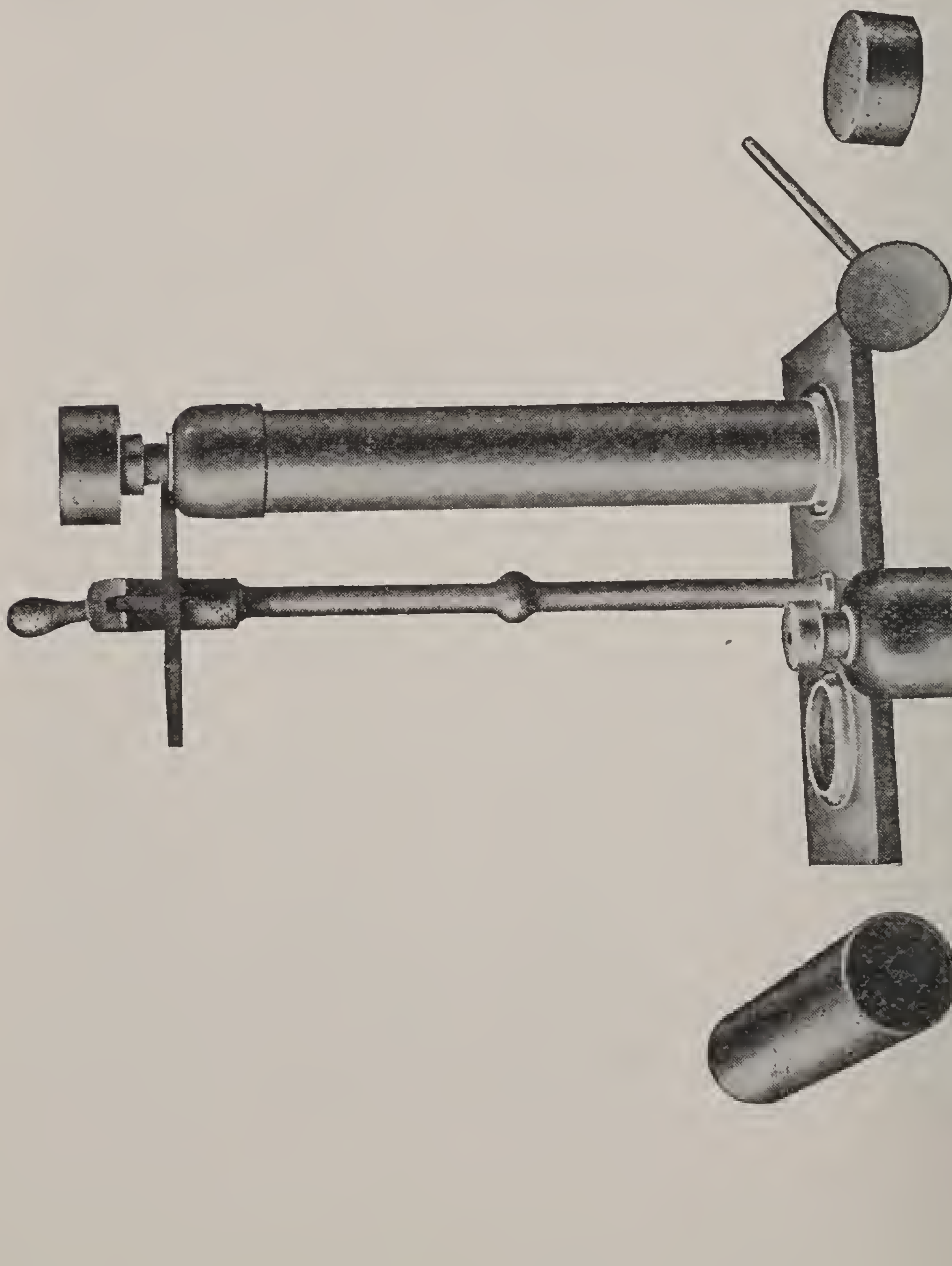


Fig. 1.—Foster's Gluten Tester, showing the parts.

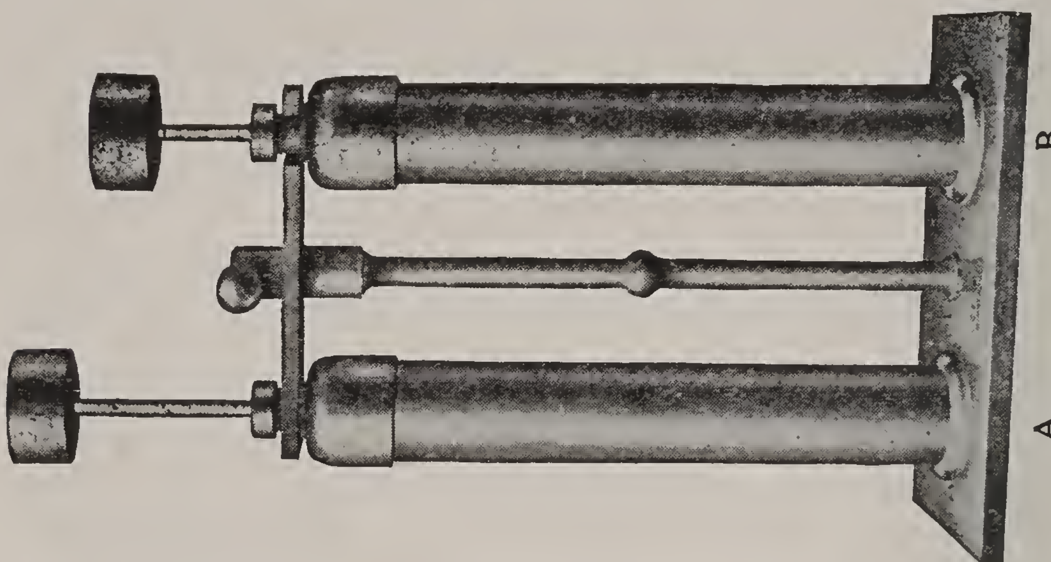


Fig. 2.—Tester, containing baked gluten.

always use the amount of wet gluten washed from 50 grams of dough. (See Practical Gluten Tests.)

I generally leave it in the oven 20 minutes, which is sufficient to bake gluten from Patent flours. But some Kansas glutens get too dry and too dark in that time, while glutens from "straight' or "clears" take longer. Some of the latter come up very quick, but have not sufficient power to hold the weight up and they settle again. In the photograph (Fig. 2), I show two such samples, after they came from the oven. The gluten in cylinder B weighed over 3 grams more than the gluten in cylinder A, and B also raised quicker and as high as A, but B fell, lacking the power of upholding the weight, which is equivalent to the gas pressure in the loaf during baking. A is a "Spring Patent," B is a "Straight."

There is a further characteristic of the gluten. If you watch different gluten samples in the oven, during baking, those popping up first will soon stop or fall back, while the glutens from the best patents generally raise slow but sure, and never settle.

In figure 3, I reproduce samples of gluten from different grades of flour, baked in Foster's apparatus.

A. Gluten from 60 percent Spring Patent. Shows good strong fibre and light brown color.

B. Gluten from 60 percent Kansas Hard Winter Patent (middlings.) Expansion very good, but fibre not so strong and tough; more brittle and glossy, and color is dark reddish brown.

C. Gluten from Second Spring Patent (about 75 percent). Fibre and shape strong and solid. Color good rich brown.

D. Gluten from Kansas Hard wheat Patent. About 70 percent. Expansion was good but as shown in photo it settled some, fibre being more delicate and brittle; break up very easy. Color a good deep, rich brown with reddish tint. Very glossy.

A B C D E

Fig. 3.—GLUTENS, WASHED FROM DIFFERENT FLOURS.

A, Gluten, from First Spring Patent. B, Gluten from Kansas Patent. C, Gluten from Longer Spring Patent. D, Gluten from Kansas Patent. E, Gluten from Clear Spring Flour.

E. Gluten from a clear, such as used in Rye mix. Fibre very tough, and outside crust not hard or brittle; rubbery. Color a dead grayish brown.

I will refer again to these samples in Part 4, on Dough Making.

COMPARING GLUTEN (Fig. 4). The accompanying photographic reproduction of six samples of baked glutens illustrates the different characteristics, as well

Fig. 4.—Samples of Baked Gluten.

No. 1, Clear (for Rye Mix). No. 2, Kansas. No. 3. Fancy Spring Patent. No, 4, Standard Brand Minnesota Spring Patent. No. 5, Washed out of Gluten Flour. No. 6, Blend of Nos. 2, 3 and 4.

as the percentage of gluten contained in the different brands of flour. Each sample is from two ounces of the flour named. No. 1, shows the gluten from "clear" or Rye Mix; No. 2, that from Kansas Flour; No. 3, from Fancy Minnesota Spring Patent; No. 4, from Standard Brand Spring Patent; No. 5, washed out of Gluten Flour; No. 6, from a blend of the Nos. 2, 3, and 4 flour.

You will notice that No. 1 hardly raised at all, although the original piece before baking was 10 percent larger than No. 3 or 4. It had raised some first, but fell again. This shows that the quantity or percentage of gluten alone in any flour does not count for much, if it lacks in strength. This gluten can be made to raise some, however, but requires a slower heat and longer time to bake than the others.

No. 2 is taken from a Kansas Hard Winter Patent flour of exceptionally rich gluten. This gluten has also a good spring, but it will be observed that it does not come up as uniform and round on bottom as the Minnesota Spring Patent, or the sample from gluten flour. It also has a reddish, glossy color, which is noticeable by the light shading. This is characteristic of most Kansas flours.

No. 3 indicates a very high quality of gluten, compared with the gluten from "gluten flour" (No. 5). It also has a rich, brown color, and tender smooth surface, which will be noticed on the crust of any loaf of bread baked from such high grade flour.

No. 4 is taken from one of the most popular brands of Standard Spring Patent flour, milled for the bakers' trade. It is a good strong and evenly balanced gluten, but not quite as rich in color as Nos. 3 and 5.

No. 5 is washed out of a sample of flour sold as Gluten Flour. The amount of gluten recovered is much larger than that from any of the other flours; but is shows up hardly any larger than glutens from many first spring patents. The main object of the manufacturer of gluten flour is to produce the largest possible amount of gluten in his flour.

No. 6 is taken from a blend as follows: No. 3, 25 percent; No. 4, 50 percent; No. 2, 25 percent.

It will be noticed that the Kansas Gluten in the mix shows in the light spot, which is of a lighter reddish shading. It also was not quite baked, when the samples were taken from the oven and settled a little. This

indicates that the dough made from this blend can stand a little more time before being knocked down, and also before taken to the bench, and it also requires a little more time in baking.

By careful study of such comparisons of baked gluten, you run occasionally against some surprises in in finding some cheaper flour making a valuable blend with higher priced flours. Do not be deceived by the good showing of the sample of Kansas gluten No. 2). as not all Kansas flour shows up like this one; and this sample was not from the highest priced Kansas flour out of a selection of three or four either.

It has often appeared to me that the majority of millers do not pay sufficient attention to the character of the gluten in their brands of bakers' patent flour. I have often noticed that the same brand of flour does not always produce similar samples of baked glutens, although the percentage of wet gluten may be the same. The millers' statement of how large a percentage of gluten his flour contains is of no consequence to me, as I form my conclusions only after comparing the baked sample with other samples.

The flavor also varies considerably in baked gluten and gives us some idea of flavor the bread produced from such flour will have. However, I believe that the only marked effect gluten has on flavor in bread, is in the crust. Therefore the efficiency of a baker in gluten-testing makes him a good judge of flour and will surely save him some money.

How often does a baker condemn the flour or yeast, when his bread does not come out right, although he thinks he used everything the same as usual. With a few careful tests he may find that by changing the proportions of different flour in his blend, or by giving dough more or less time than usual, he will obtain the same results as before. Besides the character of the gluten, the study of gas and heat developed in the doughs during fermentation, is very important, as demonstrated in Part 4.

Behavior of Gluten in Sponge and Dough. In Figure 5 we find an interesting study of the gluten left in dough and sponges. As previously mentioned, the gluten changes or softens in the dough during fermentation and if one is able to recover any gluten at all, the same has to be placed in a little linen or bolting cloth bag and washed in ice water or water not over 45 degrees F. The same blend of flour has been used in all of these doughs, also the same amount as in the gluten tests from unfermented flour, namely 50 grams—with the exception of the glutens A, B, and C, washed from dough where I allowed 5 grams extra dough, the extra 5 grams being allowance for sugar, lard, salt, etc., used in the dough, besides the flour and water. Now it will be seen in the illustration, much plainer than by any chemist's analysis, how the gluten is lost during the different stages of fermentation.

A. The gluten washed from a straight dough after it stood for 5 hours and was ready for moulding into loaves. This gluten has a rich dark color and almost as strong expansion as the gluten from same amount of unfermented flour. In weight it lost a little more—about 5 percent. The darker color towards the top, I charge to the presence of sugar and ether extract (shortening).

B. Gluten from a Vienna sponge dough. This sample was nearly 10 percent less in weight, due to the gluten dissolved by acids in the sponge. But the expansion is nearly as good in proportion, as from unfermented gluten.

C. Gluten from a dough made with an older sponge (8 hour). Loss in weight through acids in sponge about 25 percent; but the loss in expansion is not so large in proportion.

D. Gluten from Vienna sponge (4½ hours). This sponge shows about 30 percent loss in weight due to action of acids. Expansion is getting weaker, color is almost gray, and it is plainly seen in the illustration

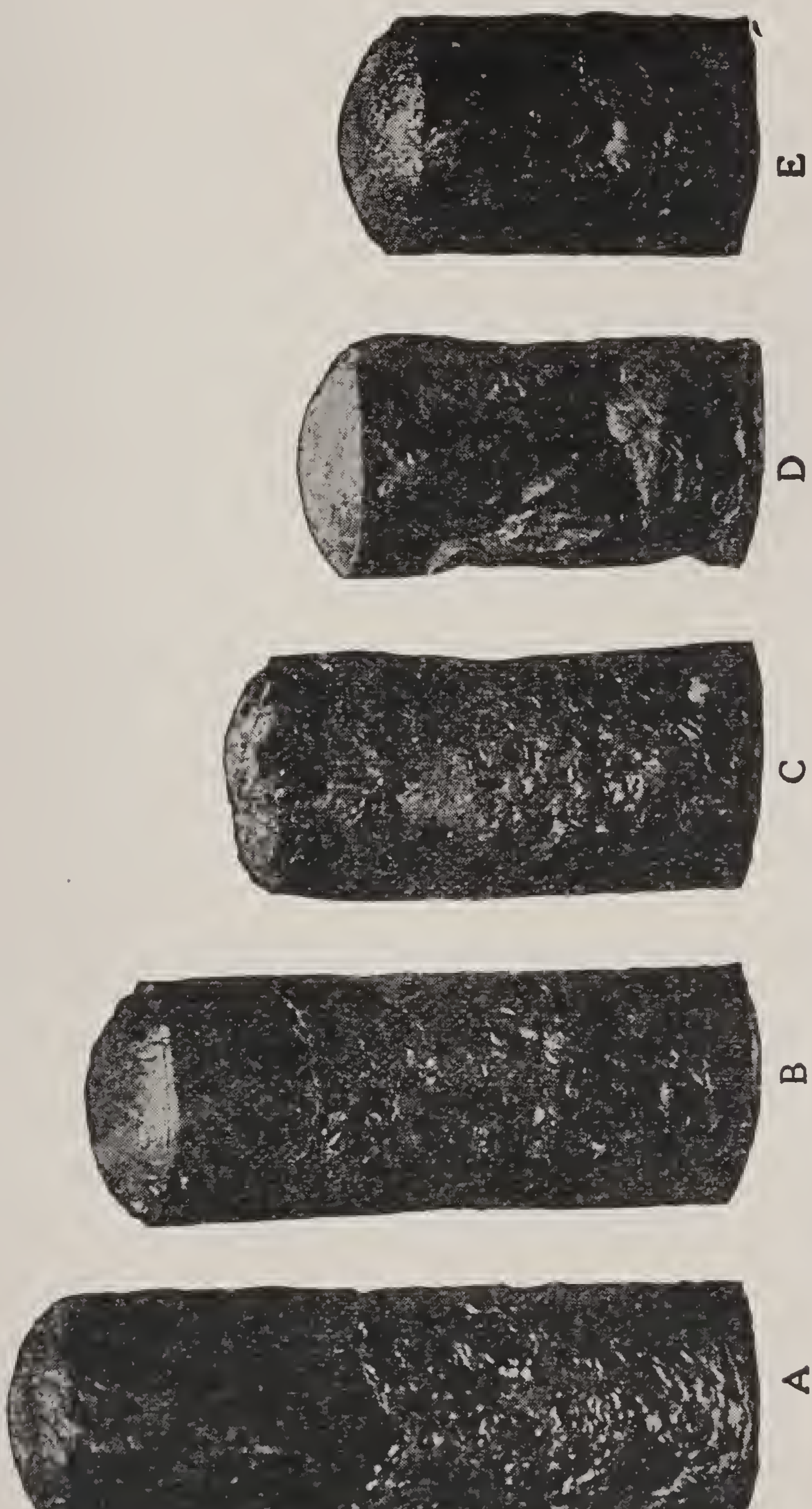


Fig. 5.—GLUTENS, WASHED FROM SPONGES AND DOUGHS.

A, Gluten washed from a straight dough. B, Gluten washed from a "short time" sponge dough. C, Gluten washed from an "old sponge" dough. D, Gluten washed from a $4\frac{1}{2}$-hour sponge (Vienna). E, Gluten washed from an old sponge (8 hours).

that the loss is mainly in gliadin, the gluten being much tougher and irregular in shape.

E. Gluten from old sponge (8 hours old). The size shows a loss in wet gluten of nearly 50 percent compared with sample A, due to the action of increased acidity, and expansion is very weak. The color is a dark, dead, ash gray, indicating that nearly all the gliadin has disappeared.

From this illustration (Fig. 5) we form the conclusion that the longer fermentation reduces the gliadin content. We know that some flours require a longer fermentation than others to produce a good loaf of bread, and hence the same method of bread making does not produce the same results with all flours, all because of the difference in the composition of the gluten in the various flours.

However, I can not see how dry gluten percent is of any particular advantage to the baker. Give me any piece of gluten washed out carefully and baked in any oven heated for bread baking, and I will tell the kind of flour it came from, and the kind of bread it will produce. You can judge the character of a gluten much better when baked; color, fibre, shape, expansion, etc.

The wet gluten is approximately three times the amount of dry gluten, so by multiplying the amount of dry gluten given by three, gives a very fair percentage of the wet gluten.

The chemical laboratories determine and compute the gluten content in flour now mostly by chemical process, giving the percentage as dry gluten. Even when washing out the gluten, it is often dried at about 200 degrees F and weighed again as "dry" gluten.

The quantity of dry gluten in a flour varies from 7 to 15 percent, according to the grade of flour The gluten content is influenced by the locality—the wheat from different states showing distinct variations. It is also influenced by the season, and is different in spring and winter wheats.

As already shown, the quality of gluten also differs; some is soft, sticky and easily tears when stretched like rotten rubber. In better flours it is firm, elastic and stretches like the best of rubber.

Spring flours show a higher gluten percent than soft winter flour. However, the Kansas Hard Winter Patent compare of late years very favorable with Spring Patents in percentage and quality of gluten. But it requires, as a rule, more care and understanding how to handle the doughs and fermentation.

BURETTES, SCALES. To get satisfactory results out of any flour or gluten tests, reliable weight and measures are a necessity. The most practical outfit is the metric system, and it is surely simple enough for any baker to master or comprehend. The unit of weight is the gram, usually abbreviated to grm. The unit measure for liquids (for all technical purposes) is the cubic centimeter, shortened to c. c.

The measure of a c. c. of water, weighs one gram; hence if we weigh 100 grams of flour and it takes up 60 c. c. of water, that constitutes the percent of water absorption (60 percent). This is very simple, to be sure. Then, if you have only 50 grms. of flour you multiply the number of c. c. of water it took, (say 29 c. c.) by 2 and you have the precentage, *i. e.* $29 \times 2 = 58$ percent of water absorption; if 200 grms. of flour are used, divide the amount of water (number of c. c.) by 2; *i. e.* 200 grms. flour and 124 c. c. of water—$124 \div 2 = 62$ percent of water, and so on. The simple instrument for the exact measuring of water, which every baker can afford to possess, is called a *burette*. It is a long thin glass tube, with stopper and delivery tube at the bottom to regulate the flow of water. The tube is accurately marked to hold a certain number c. c. of water, say, 50, 70 or 100 c. c., and the graduation of each c. c. is marked carefully on the tube, 100 c. c. measure a trifle more than 3½ ounces (3.52 fluid ounces) and 28.35 grams equal one ounce.

Now, to get the gram weight of small samples of flour and exact weight of gluten, a small accurate balance (scale) is another handy apparatus. It should be equipped to weigh as small amount as one-tenth of gram (decigram). However, if a baker does not possess any burette or metric balance, he can take two ounces of flour and a trifle over one ounce of water for his gluten tests.

LABORATORY TEST OF FLOURS.

I recently sent ten different samples of flour to a well known laboratory for analysis to use them in comparison with my practical tests, which I have made with samples of the same flour. The report is reproduced in this chapter. The samples I sent were only numbered, no brand or name of flour they were taken from was mentioned.

The top line gives the analysis of a high grade Spring Patent, used by this laboratory as their standard.

Notes referring to table:

No. 1. High priced fancy Patent, extensively advertised for family trade.

No. 2. Well known brand of Bakers' Spring Patent.

No. 3. Medium priced Northern Bakers' Spring Patent.

No. 4. One of the best known Short Spring Patents. (Bakers' brand.)

No. 5. A strong Bakers' Hard Spring Second Patent.

No. 6. Same as No. 4. (Family brand.)

No. 7. Highest priced fancy Kansas Patent.

No. 8. Kansas Hard Winter Patent.

No. 9. Another well known Kansas Middling Short Patent.

No. 10. Kansas Turkey Hard Wheat Flour, medium priced.

LABORATORY TEST OF FLOURS.

SAMPLE	A Gluten per cent	B Ash per cent	C Absorption per cent	D Color	E Loaves per Bbl.	F Size of Loaf	G Quality of Loaf	H Average Value	I Ferment-ing Period	J Quality of Gluten	K Moisture
Standard	11.0	.42	62.	100.0	100.0	100.0	100.0	100.0	100.0	100.0	12.9
No. 1	12.8	.42	65.	99.0	101.8	100.0	100.0	100.0	107.0	92.6	11.4
" 2	12.8	.63	66.	91.0	103.4	100.0	98.0	97.8	107.0	92.6	12.6
" 3	12.4	.55	67.	92.5	103.0	100.0	98.5	98.5	105.9	94.0	12.0
" 4	11.3	.44	65.	97.0	101.8	100.0	99.5	99.6	101.3	98.6	11.1
" 5	12.4	.56	66.	90.0	102.4	100.0	98.0	97.6	105.9	94.0	13.0
" 6	11.3	.44	69.	96.0	104.2	100.0	99.3	99.9	101.3	98.6	10.0
" 7	10.2	.41	65.	99.5	101.8	100.0	99.7	100.2	96.3	103.9	11.1
" 8	11.0	.54	64.	94.0	101.2	100.0	97.5	98.2	100.0	100.0	12.6
" 9	11.4	.50	65.	95.0	101.8	100.0	98.0	98.7	101.8	98.2	11.7
" 10	11.3	.47	68.	95.0	103.6	100.0	99.0	99.4	101.3	98.6	9.9

No. 1, figures more gluten than the standard, but quality of the gluten is poorer by nearly 8 percent. Acording to the ash percentage this flour figures a very short or fancy Patent, and quality of loaf is equal to standard (100) although poor quality of gluten would seem to lower its value.

No. 2, also shows the same percentage of gluten as No. 1. The very large percent of ash (21 points more than No. 1) proves this to be a much longer Patent; color is poor, which is only natural considering the large amount of ash.

No. 3. Percentage of ash and color figure this medium Patent belonging between No. 1 and No. 2, but quality of gluten is given a higher percentage.

No. 4. Although gluten percent is smaller than in either No. 1, 2 or 3, the quality is considerably better; color and every other item compares very favorable with the standard.

No. 5. In every respect about the same commercial value as No. 3, all the different comparisons being nearly the same.

No. 6. In every respect about the same as No. 4. The large absorption is accounted for by the lower moisture content.

No. 7. The analysis of this flour is remarkable in several ways. Although the gluten percent is the smallest of all samples, the quality of same is also superior, including the standard. Ash content is also lower than the standard, which also accounts for shorter fermenting period.

No. 8. In ash contents, this Kansas flour would figure as a medium patent; gluten content is the average of a good Kansas, but the quality of same shows better than the average.

No. 9. Although the quality of the gluten is somewhat below No. 8, the average value of the flour and quality of loaf is figured higher than No. 8. This

result is undoubtedly due to its smaller ash content and better color.

No. 10, shows up better than No. 8 and 9 in most every respect. The remarkable low moisture naturally means a larger absorption.

As general summing up, it is shown that the fermenting period is governed by the amount of gluten which every flour contains, and also by the quality of the gluten. That flour which contains the largest amount of gluten will generally require the most fermentation to get it ready for baking. This may be obtained in two ways; by giving dough more time and using the same amount of yeast, or by using more yeast and giving the usual time.

NOTE—The best guide the baker has in choosing which of these two methods to employ is the acid test given under heading of Practical Tests. If flours with a large acid content, such as 2 and 5 (see Practical Tests), are given a long fermenting period the acid fermentation will increase too rapidly, as the alcoholic fermentation slows up, and the result is sour bread. In a case of this kind it is advisable to use more yeast, to hasten fermentation, rather than give the dough more time. This is really a necessary test to make in conjunction with the laboratory test to find ont the nature of the acids and ferments of the flour. The laboratories can furnish a report on acid content in a flour, but from it the baker can not quite judge the effect it will have on a large dough. This simple yet practical method of doughing up a small amount of flour and allowing it to stand twenty-four hours, will show him to what extent the acid contained in his flour will affect the larger doughs.

PRACTICAL FLOUR TESTS.

On the following plates (I and II) you will find illustrations of my own practical tests carried on with the same ten flours used in the laboratory or chemical tests shown on above table.

Plate I, shows samples 1, 2, 3, 4, 5.

Plate II, shows samples 6, 7, 8, 9, 10.

These numbers correspond with the numbers of the laboratory analysis.

The top line on both plates show the baked gluten of the different samples.

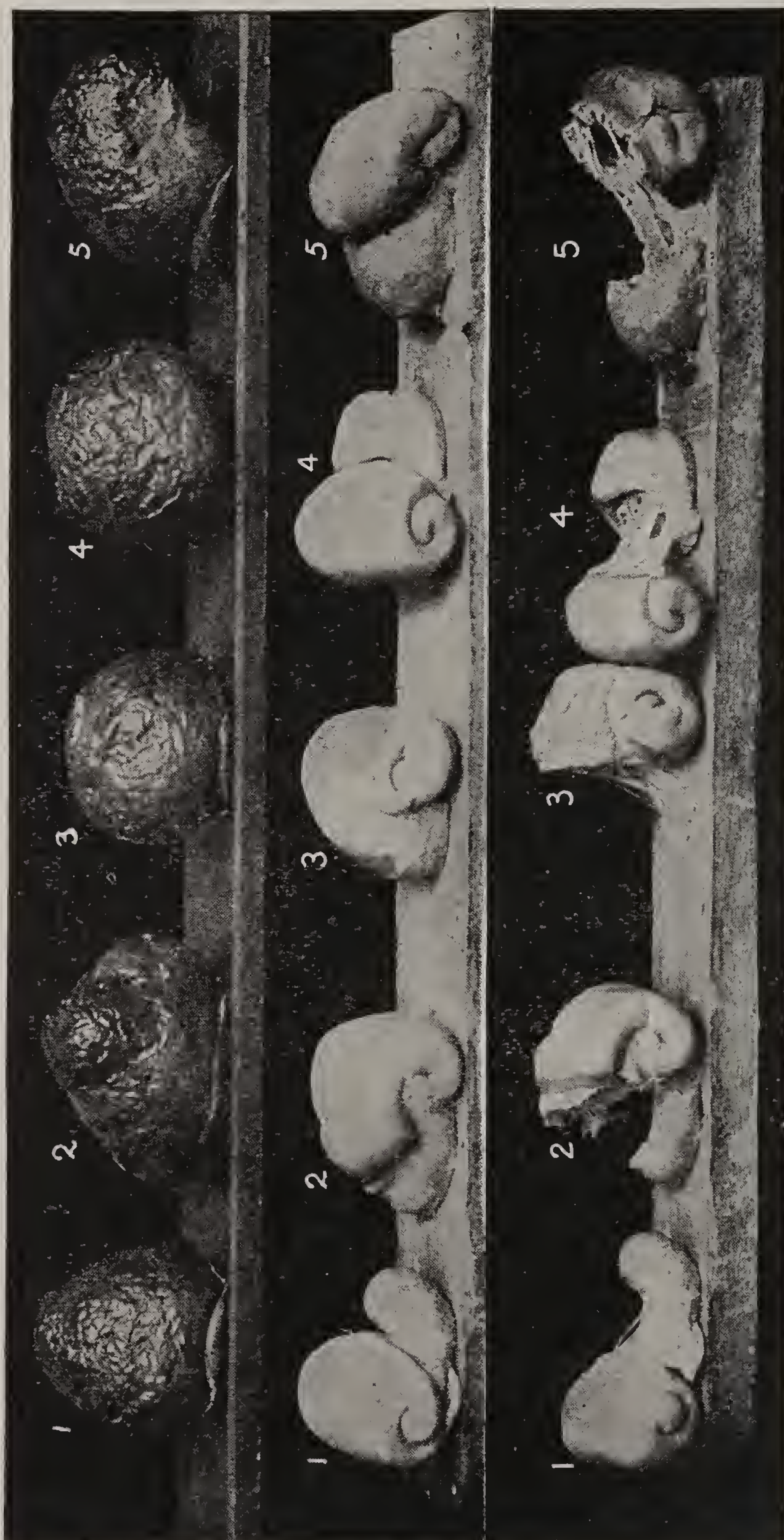


PLATE I. PRACTICAL FLOUR TESTS.—Top line showing *Gluten;* second line showing *Color;* bottom line showing *Acidity.*

PLATE II. PRACTICAL FLOUR TESTS.—Top line showing *Gluten;* second line showing *Color;* bottom line showing *Acidity.*

The second line shows the small pieces of dough, each taken from the same dough that the corresponding gluten was washed from.

The bottom line shows acid ferments in flour after standing 20 to 24 hours.

From the color of these pieces of dough I judge the color of the flour and make a note of same. Taking notice of the color again in about 24 hours you can judge the value of the flour as to color of the crumb in the baked loaf. In some flours the change is quite noticeable, changing to gray or brown. I find these color tests more reliable than the customary dipping test. After 24 hours a hard crust has formed on the outside of each of these pieces, but you will find on each a blister-like eruption formed on the side as seen in the illustrations. Now the large pieces are pulled away from the smaller blisters, gently. During the 24 hours a chemical change has taken place inside of these pieces of dough, a kind of spontaneous fermentation, the acid bodies in the flour also having more or less acted upon the gluten. Some can be pulled away in long strings without breaking, which indicates a richer gluten and a well balanced acid content. Others will break short and in a solid mass, which indicates stronger acids and more ash. Some very strong second patents or straights will hardly have anything left but the thick shell, the inside having been all eaten up or decomposed by acid ferments, and a disagreeable sharp smell is also noticeable in some cases. By comparing these different samples with the laboratory analysis, you will, in most cases, find that the characteristics pointed out in the practical tests correspond with the percentages of the laboratory reports. However, I frequently find that my practical tests give a better indication of the actual value or working properties of a flour, when made into large doughs.

We will now explain the preparation of the samples of gluten and dough shown on Plate I and II.

Starting with flour No. 1, the same process is repeated with the others, seeing that the right number is attached to each sample. Of course when so many samples are to be made, as in this case, we only mix up five at one time, washing out the gluten of those first and while they bake, proceed with mixing the others.

Method of preparing samples: 50 grams flour and 27 cc. water are mixed into a smooth dough, using same utensils and same method as mentioned in gluten tests. Have water same temperature you would use in a large dough to make it 83 or 84 degrees when mixed.

Next, 50 grams of this dough are weighed off and set aside to soak from 20 to 30 minutes in a cup or beaker of cool water. The starch is then washed from the gluten.

In the meantime the remaining piece of dough is kneaded into a little oblong roll (as shown on Plates I and II, second line) and set on a smooth slab of wood or glass. These little pieces of dough are placed in a warm place (83 to 85 degrees F.) for 20 to 24 hours. But as they must be guarded against draft, it is best to have a small box made to place them in, leaving one side or top open. Now having all reports and samples before us in the illustrations, we will compare the results.

SAMPLE No. 1. The baked gluten (top line, Plate I) shows a good brown color and not many blisters but not having expanded quite round and symmetrical, indicates the presence of some fancy, soft Winter or short, rich Kansas Hard Winter Patent. The wet gluten weighs 16.40 grams, or 44 percent. The color of same is a creamish yellow with greenish streaks, it runs some but is not sticky. The second line (Plate I) shows good color, cream white; the acidity of the dough (see bottom line) indicates some healthy acid ferments, but the strings running together into

a sweaty, solid mass, shows weakness of gluten which again points to presence of winter flour.

Comparing both the chemical or laboratory analysis and practical test, the results of both show this flour to be of a better value to the housewife for general baking than the baker. He can get lower priced flours and blend them to get same results or same quality flour for less money.

SAMPLE No. 2. The baked gluten has a dark brown, glossy color, which together with the thin, irregular, puffed-up shape indicates a large percentage of gliadin in the gluten, but the total gluten content being very large also leaves sufficient glutenin to hold it up after a very large expansion. This makes the gluten more valuable to the baker. Wet gluten weighs 16.5 grms. (44 percent), is grayish yellow with dark green spots, feels very firm and tough, but after standing awhile softens down. But as shown on second line Plate I, the color is off considerable, being a dark grayish brown which indicates large ash content. This flour is better for a blend with a better colored, shorter Spring or Winter Patent. This is all the more advisable on account of the strong acid ferments (shown on bottom line, Plate I). The dough breaks off short, the acid ferments in the flour having eaten up or dissolved most all the gluten. This flour is really worth more money to the baker than the laboratory report indicates and I have used thousands of barrels of it in the last two years with the best results in our blend.

SAMPLE No. 3. Baked gluten shows up fairly good and uniformly balanced; wet gluten, 15.9 grm. (43.8 percent); color a deep yellow with greenish streaks. Works firm and tough and does not soften very much.

Second line (Plate I) shows dough of good cream color, little dark, and when pulled apart (see bottom line) shows healthy acid ferments and a fair strength

for gluten. Comparing my practical test with the laboratory analysis both reports give this flour about the same value as a fair Bakers' medium Spring Patent.

SAMPLE No. 4. As shown on Plate I, (top line) the gluten in this flour is perfectly balanced in glutenin and gliadin which gives a uniform expansion and good, rich, brown color. Although the wet gluten is less than some of the other samples, weighing only 13 grams. (40.1 percent), it makes up in expansion and quality. This gluten is very elastic and firm, does not soften or run flat and has a rich cream color with greenish tint and green streaks. This is equal to 100 percent or perfect. Color of dough (second line) is clear, rich cream. This is also good for 100 percent. The piece of dough on bottom line shows a firm shell with large even eruption on one side, and when pulled apart, the dough shows a number of tough, rubbery strings, which are very elastic and withstood the attacks of the acids very effectively. I consider the acidity sufficiently strong and healthy to assist perfect fermentation and produce a good flavor.

The laboratory analysis on this flour corresponds almost in every item with my practical test. This is the flour I have used as my "Standard" for the last two years.

SAMPLE No. 5. The baked gluten points to a rather long or second hard Northern Patent flour, indicated by its greenish gray, dull color and thick, tough shell, which together with the more solid fibrous interior, indicates an overbalance of glutenin. The wet gluten weight is very large, 14.4 grms. (44 percent), but as may be expected, is of very poor color, a grayish yellow, with deeper, nearly brown spots. No sign of a greenish tint.

As may be expected, color of dough (see second row, Plate 1) is also poor, a dead ash gray. Broken open (see bottom row) the crust appears to be very thick and the large blister formed by the acid ferments,

indicates strong acidity, but nevertheless the gluten is tough enough to withstand the attack of the same, as plainly seen in illustration. This flour is all right to use in a blend with a short Spring or Kansas Patent of good color and rich flavor, or a soft Winter.

SAMPLE No. 6. As already mentioned in laboratory analysis, this sample is same brand of flour as No. 4, only this is the Family Brand. Color of dough is a trifle whiter than No. 4, and acidity a little stronger which shows plainly on Plate II, bottom row.

SAMPLE No. 7. This is the most remarkable sample in the lot. The baked gluten is smaller than any of the others, but in consideration of the small percentage of wet gluten, 11.5 grms. (35.5 percent) the expansion is not bad. The color of baked gluten is a delicate, even, golden shade, and the shell and interior is exceptionally mellow and tender but not brittle or glassy. The wet gluten has that rich, creamy, yellow color, and after standing a while, light greenish streaks appear over the top. It feels mellow but dry and stands up firm and well rounded. The dough (second row, Plate II) has that rich, clear creamy color and feels very elastic but mellow and tender. The acid ferments in this flour are not very active, but their presence is noticeable when you break the piece of dough open. The interior presents a rich, stringy mass, softened and mellowed by the ferments, but has a healthy, pleasant smell. In comparing the practical test with the laboratory analysis, the reports are very similar, and although gluten content is remarkably smaller than in any of the other samples, the quality of the gluten and the quality of loaf in every respect, especially the color and flavor, stand out even above the standard. This is the flour I have for years referred to as the nearest to the celebrated Hungarian Kaisermehl, and I know a number of bakers who keep this flour as a special fancy brand to use for French and Vienna bread and rolls, or as a blend especially for its fine flavor.

SAMPLES No. 8, 9 and 10. These are all three good Kansas hard winter wheat Patents and compare very favorably with the average Spring Patents. However you will notice from the appearance of the baked glutens (top row Plate II, No. 8, 9 and 10) the characteristics of most Kansas hard winter wheat flours, that the gluten in baking expands more or less irregular, breaking out in very thin, glassy blisters, which will either burst or shrink soon after the gluten is taken from oven. They show good expansion in oven, but are of a foxy reddish color. Wet gluten= No. 8—13.5 grms. (41.0 percent); No. 9—13.6 grams. (41.9 percent); No. 10—13.8 grms. (42.2 percent).

(For further explanation see chapter on gluten.)

Color of these Kansas flours is fair, only more of a pinkish cream than the Spring Patents. Acidity is quite strong, but the natural ferments in the flour are not so active as in most Spring Patents. The acids work more on the gluten which would suggest a shorter fermentation period and different handling of the dough.

STORAGE AND AGING OF FLOUR

In Europe the larger bakers kept their flour supply in the top floor, called the "Mehlboden." The different grades are dumped into large separate bins, first being sifted. The rooms are well ventilated, airy and lofty. The floors are laid with tile. The flour is frequently turned over and stirred up with large wooden shovels; this is of great benefit, especially in aging newly milled flours and flour milled as soon as new crop wheat is harvested. Flour stored in bags should be changed at least once a month and not piled over eight bags high and rows kept apart to allow for circulation of fresh air.

Referring to sifting flour, before storing it; that will help considerably to improve new flour. If there are no bins where it can be kept and stirred, it may

be put into barels after sifting. This suggestion concerns the small baker as well who has little room or not the means to lay in more than a week's supply. If only one or two days' suply is sifted ahead, it will be an improvement.

Some bakers keep their flour over the hot ovens to age it quicker. I do not approve of that; or, at least, it should not be allowed to get too warm, and must frequently be changed around. I know many large bakers who do not hesitate at any expense for the latest machinery and improvement, but shy at the expense of a cheap extra laborer in the flour room to change the flour frequently. They do not seem to want to recognize the fact, that the extra expense of a few dollars a week for labor will improve their flour tenfold that amount.

I have stated before, that direct sunlight hurts the flour. Trouble with old flour, often begins when the new wheat begins to sprout in spring; in some years more than in others, some wheat will commence to sweat. Therefore, the flour milled from it acts older towards the end of the old crop, and I find that one month storage is the proper time as compared with two months within four months of harvest, and three months for flour milled from new wheat.

Flour is also very susceptible in absorbing odors from things placed near it. For instance, place a basin of kerosene near some sacks of flour, or near a trough filled with flour, and you will discover in a few hours that the flour is tainted with a kerosene smell; paint and kalsamine have the same effect. Sulphur fumes and chloride of lime, etc., will even effect the gluten.

PART 4.

Dough Making, Proper Temperature, Bread Formulas and Standards.

DOUGH MAKING.

SPONGE DOUGHS AND STRAIGHT DOUGHS. The method of making bread differs in various countries. In Germany and Austria the baker sticks to old-time "Sauer" and "Vorteig;" the French baker still makes his famous "pain de luxe" by setting a "pouliche" or batter first, or using the leaven (*levain*) left over from the day before, to start his doughs with. The Scotch baker thinks there is nothing like his "barm" or "quarter sponge;" the English baker likes his "ferments" or sponge doughs, although he is getting used to the straight dough system which he calls "off hand" dough; the progressive American baker thinks there is nothing like a "straight" dough.

The system of first setting a sponge is no longer the prevailing method in the larger bakeries; sponge doughs are only used for hearth bread, such as Vienna and Rye and Hotel bread, Pullman, Snowflake, etc. But many of the smaller or retail bakers still cling to the old time "long" sponge, because they think it is more convenient.

He sets his sponge in the evening at 8 o'clock, goes to bed and lets the sponge take care of itself until 4 or 5 o'clock in the morning. He then makes a whole variety of doughs out of the one sponge, such

as Home-made, Vienna, Graham, Rolls, Coffee Cakes, Buns, and some even use it for Rye dough.

However my advice to all is to discard this antiquated method as much as possible, as it is against the laws of fermentation to hold a sponge or dough too long. The time when a sponge or dough is at its best, is very short. But where two or more kinds of bread and perhaps rolls must be made out of this sponge, my advice is to weigh out the amount of sponge needed for each dough, instead of first breaking down the sponge with water needed for dough making and then dipping it out, as some old timers are still in the habit of doing. Sponges are called "short" sponges (3 to 6 hours) or "long" sponges (6 to 10 hours), according to the length of time allowed them to get "ripe."

SPONGE DOUGHS. There are some advantages to the "sponge" method. A sponge dough requires only about half the amount of yeast than a straight dough.

A sponge can stand a longer time when ripe, while a straight dough must be worked up when ready.

Where "volume" or size of loaf is the main object, the sponge dough is the thing.

Cheaper grades of flour, or stronger flour, can be used in sponges to better advantage.

A sponge dough can be better regulated, especially when new, or when young flour is used. If the sponge comes slow or too fast, you can hasten or hold back the dough by regulating the temperature of the water, and increasing or cutting the amount of salt. Or, if any extra order comes in, you can pour on more water.

SHORT SPONGES are generally used for "Hearth" bread, such as Vienna and Rye, also Vienna and French rolls. Making a comparatively soft sponge, more water can be used than in a straight dough, besides you can develop a real good "nutty" flavor and get a better testing, crisp, tender crust on "Hearth"

bread than with a straight dough, at the same time using less sugar or yeast food, milk and shortening. A "short" sponge should only be allowed to break, or drop one time.

Doughs from short sponges I do not mix as much as straight doughs. Some bakers use too much of the total liquid (water or milk) in the sponge, but I prefer to pour nearly as much on dough as on sponge. For instance, if I want a Vienna dough of 100 pounds of water, I set sponge with 60 pounds of water and pour on for dough at least 40 to 45 pounds. It makes a closer loaf. For short sponge doughs, let dough come up once until it starts to break, then knock down and let come half way again, no more.

LONG SPONGES are used for Columbia, Hotel or Pullman and Cream Bread. They are made stiffer (say 13 to 15 pounds of flour to the gallon of water), and stand from 7 to 10 hours. Only about half as much yeast is required as in Straight doughs.

For Cottage or Pan loaves made from long sponge dough, the dough is run through brake only six times but for Sandwich, Hotel and Pullman it requires 14 or 15 times rolling.

The oftener you roll such old sponge dough, the whiter the crumb and the higher the loaf will be.

Long Sponge and Dough. The long sponge must be set stiffer, as it slackens considerable after standing about 5 hours. It can be allowed to drop the second time, especially if the dough is run through the break. A large sponge requires less yeast (in proportion) than a small sponge.

Care must be taken that a sponge is not disturbed after it is half raised as it falls by the least touch or knock.

The time for a sponge to ripen can be lengthened by increasing or lowering the temperature of the water, or by using more or less yeast, or by using more or less flour thereby making the sponge tighter, stiffer, or slacker (softer).

When yeast is scarce, a little old or weak, you can make it stronger by making a small batter with the yeast, a few pints of warm water, a very little malt extract or malt powder and sufficient flour. Set this away for about 20 minutes, covered, in a warm place. Then set the sponge with it, adding the water and flour.

Figure 1.

No. 1, Loaf made of "short" sponge process; No, 2, Loaf made with all the same ingredients except a "long" sponge is used.

Why a dough made from a sponge produces a larger loaf, is principally due to the addition of the sugar or yeast food (malt extract), as well as the sugar or diastasis converted from the starch of the extra flour added in dough making. As we learned in Part 2, sugars produce alcohol and gas and as the dough after being made from the sponge only stands from one to one and a half hours, we get a fresh

healthy supply of food for the yeast and consequently more fresh gas production which means better expansion. Furthermore, we have a new supply of gluten in the dough making.

But, as we further know that the acidity increases, the longer fermentation is allowed to go on, the remarkable expansion power of a dough made from an old sponge of 7 to 9 hours, must be due, to a great extent, to *"acetous"* (acetic) ferments. (See Part 2.)

To illustrate this fact, I refer to Figure 1, which shows a loaf of very large volume, and rich, healthy color and fine tender but crisp crust. Loaf No. I, is made from "short" sponge dough (4½ hours), but sponge and dough being set rather soft. Size, color and flavor are very good and texture solid and even. Loaf No. 2 is made from a "long" (8-hour) sponge dough. However, as this sponge and dough have been set stiffer, the size of loaf shows to be smaller (same weight). It has a mild but not unpleasant acid flavor which, however, a great many people like. The crumb is of somewhat darker color, and more open, but not coarse or dry.

Now I have tried in different ways to produce this loaf with a straight dough but found it impossible. It will get soft after it has been out of the oven for a while, no matter how hard baked, and it will never spring so high and round; it lacks that "bouncing" strength. I can use quite some second grade flour, and very little "dope"—sugar and shortening. The flour, gluten, yeast and natural acid ferments (sponge) do the work. I make another loaf, (cottage) from an old (8-hour) sponge of which we make from 5,000 to 7,000 loaves a day, and although they weigh not heavier than our straight dough loaves—and I have tried to substitute the same shape loaf (double loaf) made from a much richer straight dough—some customers want that loaf, and they seem to like that slight acid flavor, in preference to the richer loaf. The only difficulty is, to get rich, brown colored crust, and I use a small amount of malt extract for this purpose.

A small amount of salt added to a sponge is to be recommended, especially when flour contains considerable acidity and in "longer" sponges. I figure one to two ounces for every 25 pounds of water used in sponges, the larger amount in stiffer and older sponges.

Short sponge doughs like Vienna do not require so much salt as old sponge doughs. In damp and rainy weather, especially in close murky summer days, Hearth bread (like Vienna, Rye, Cornmeal and French) is likely to lose its crispness, and crust gets tough and rubbery, no matter how hard the bread is baked. This is due partly to the hydroscopic character of the salt. My dough-mixers are instructed, whenever the weather changes as above mentioned, to cut down the amount of salt 1 to 2 ounces on every pound of salt used regularly.

Bread made from sponge dough also does not require as much sugar or shortening as straight dough and keeps moist and fresh longer. You can in fact, produce a good pan loaf with hardly any sugar or shortening from sponge dough, while a straight dough without sugar, shortening, malt or milk will make a mighty poor loaf of pan bread, even if a better grade of flour is used. Bread made from sponge dough has a more velvety feeling and is more spongy. One important point to get best results from a sponge dough is to make and keep the dough warm; at least at 83 degrees. Sponge can be set cooler as it warms up more than dough during fermentation. If sponge dough is too cold, say below 81 it will sweat and get sticky. The loaves lack expansion in oven, and flavor after being baked is not there.

Some experts advocate to give sponges a very good mixing or beating, at fast speed, but I believe this is not only no advantage but detrimental. A sponge does not require so much air or oxygen, as the certain oxidizing processes during fermentation means more or stronger or too much acid formation, which weakens the gluten. I mix sponges very little and

leave to natural fermentation. Sponges must be broken up well first with the water, sugar, salt, malt, etc. before adding the flour for mixing the dough.

If a sponge happens to get too warm (say 86 degrees) for some reason, you will get rid of some of that fever heat by mixing the sponge first with part of the dough-water and salt, adding a few pounds of ice. After breaking it up, let stand a while before adding flour, etc. Pour on the rest of the water gradually, by dipperfuls, adding to each dipper a handful of extra salt. You will be surprised how the sponge gives out its heat. I compare an over-heated sponge or dough to a fever patient; the heat or fever can only be drawn out by ice and salt or ice water added gradually. If a sponge can not be worked off in time, for some unforseen reason, throw it into the mixer and add part of the water and salt, and give it a few turns to break it up; water must be colder than usual by several degrees, or in summer a few pieces of ice can be added as sponge warms the water. This will keep it fresh for some time.

Never take a sponge too young, as no matter how long you let dough stand afterwards, it will work young and wet and bread will be small and heavy, coarse grained and dark. Any sponge must at least break before you can make the dough. If you have a piece of some older dough on hand, break it up with the sponge and mix dough a little softer, increasing the amount of salt also.

STRAIGHT DOUGHS. One of the advantages of straight doughs over sponge doughs is the saving of time and labor, as all the ingredients are mixed at one time and length of fermentation can be controlled at will, according to amount of yeast used; however, best results as to sweetness and flavor, also texture, are obtained from straight doughs standing from 4½ to 6 hours. Straight doughs standing over 6 hours will not make as good a loaf of bread, and they must be made stiffer. A straight dough needs more

mixing than a sponge dough, as the gluten must be stretched and worked more. The condition or change of weather does not effect a straight dough as readily as it will a sponge or sponge dough.

A sweeter loaf and a loaf of fine texture can be made by the straight dough method; also a fine rich flavor can be imparted, but it requires considerable extra stimulants, such as sugar, malt, lard, milk, etc.

I get best results by setting a short time ferment of yeast, prepared cornflour or flakes, malt and some water, as described in Fermentation. However, a straight dough must also be watched more closely. If knocked down too soon (first time) it will never have the same expansion and bread will be heavy and coarse. On the other hand, if it gets too old, the bread will be worse than from an old sponge dough and no mixing or coaxing along with extra yeast will improve it.

You can take a small piece of old dough and use it as a leaven, freshening it over several times and you can build up a good fermentation that way, but you can not do it with a whole straight dough, if it has become sour.

I used to believe in cutting over the straight doughs, but I came to the conclusion, that this destroys the flavor. I only have a dough cut over if it gets too warm or has to stand over its regular time. A straight dough should never be allowed to stand until it settles or falls. If flour is new or young, then you can cut dough over once, after first knock down.

A straight dough should never be over 84 degrees when mixed, and it can be mixed at 78 degrees—but never lower, as explained before.

Sweet Dough for Buns, Coffee Cakes and Rolls. The same rule applies here as stated before. The amount of material added to the flour, water and salt does not alone make the difference in quality. I prefer a straight dough for all sweet goods. For instance, you use a very fancy Spring patent flour and blend it

with 10 to 20 percent of rich soft Winter patent for sweet dough; you can save on sugar and shortening but may use more yeast. The same when you use pure milk or milk-powder, you can reduce the other improvers. For all coffee cakes, especially when butter is used, the same should always be creamed up separate with part of the sugar and the eggs, and added to dough when it is partly mixed. This also applies to Hot Cross buns and all sweet bun doughs and rolls.

Sweet doughs are also improved by making a batter of the malt (liquid or powder) with sufficient water and a few pounds of corn flakes or corn flour, and set it aside for 20 to 30 minutes, adding it when dough is partly mixed.

PROPER TEMPERATURE.

Is there anything as important as proper temperature in bread making? I say NO. And still there are so many diversions of opinion, that it is a hard matter to draw conclusions too close. Having explained the nature of yeast, flour, etc., and the cause and effect of fermentation, we come now to the actual work of dough making. The most important instrument in the modern bakery, no matter how large or how small its output, is the thermometer. And not only one do we need, but several, as the success of our baking depends on the free use of this instrument. We need it:—

1. To ascertain the outdoor temperature before we start work.

2. To get the temperature of the bake room or mixing room.

3. In the dough room and moulding room, the proofing room, and finally the ovens. In the dough room we ought to have two thermometers as the temperature near the floor and ceiling often differ several degrees. This affects dough in iron or steel troughs more of course than in wooden troughs.

4. To get temperature of flour every day. This should be done if possible after flour is blended and sifted.

5. To regulate temperature of water correctly, as by this we regulate the temperature of the dough and this is of the greatest importance.

6. To watch the temperature of the dough. The dough-thermometer is the most expensive one needed, but it pays to get the best, as I myself have tried cheaper substitutes. The up-to-date mixer or foreman depends on his dough thermometer just as much as the physician depends on his little, delicate looking thermometer in watching his fever patient.

HEAT CALCULATIONS IN DOUGH-MAKING.

There have been a number of different methods published from time to time for calculating the proper heat of the water required in dough-making to get the dough at the required temperature. The average baker has no time for theorizing, but he should make some effort to master some fundamental principles of natural laws and become able to carry out certain mental calculations. Heat calculations are certainly of vital importance in dough-making, as they effect fermentation and proofing more than anything else. The best of flour and the purest, strongest yeast can be spoiled by the baker if he abuses them through extreme temperatures in mixing his dough either too cold or too warm. Therefore, it is essential that we first find out the meaning of the term.

Specific Heat. The principles of Heat, Heat Units and Calories are thoroughly explained in Part 5. (See Combustion.) By specific heat, we mean the quantity of heat necessary to raise the temperature of any substance one degree compared with the quantity necessary to raise the temperature of the same weight of water one degree. Water is used as the standard or unit of calculating the specific heat of all other sub-

stances, because the specific heat of water is taken as *One*. Therefore, we understand, that a unit of heat (B. T. U.) is the amount of heat required to raise one pound of water through one degree Fahrenheit, or to express it in the metric system, to raise one gram of water from 0 degree Centrigrade to 1 degree C., one gram calorie is required. So, if we have one pound of water at 60 degrees (F) and want to raise it to 80 degrees (F) or 20 degrees, we require 20 units of heat (B. T. U.) (See Part 5.)

The principle involved in getting dough at a certain heat is that all substances which have more or less warmth or heat will part with this warmth when they are brought in contact with cooler substances, until all are at an equal temperature. For instance, we mix one pound of water at 60 degrees (F) with one pound of water at 80 degrees, the colder water will absorb the heat of the warmer and rise as the other falls, until the temperature is half way between, which in this case is 70 degrees. But if we take 2 pounds of water at 60 degrees (F) and only one pound at 80 degrees, the resulting temperature of the mixture will not be 70, but only a trifle under 67 degrees, because we have a smaller amount of heat, having only half the quantity of the warmer water.

However, when we mix different substances, say water and flour together, the resulting temperature of the dough is different. The specific heat of flour differs from that of water (the average is 0.40) which means that a given amount of flour requires less heat to raise it a given number of degrees or heat units, than does an equal quantity of water, or on the other hand, the same quantity of heat will raise a given quantity of flour to a higher degree of temperature (or more heat units are produced) than it will raise the same quantity of water. This leads us to the fact that one pound of water will part with as much heat as will raise two pounds of flour to a temperature exactly between the two.

We may figure the average specific heat of flour at 0.40 but there is no end of exceptions or differences. For instance, different kinds of flour vary in specific heat; for instance, for Rye sponge and dough and Graham, I take the water cooler than for wheat flour sponges and doughs, although the flour has the same temperature. (See Mixing-room Chart.) Even in the same flour the specific heat varies; it requires more heat to raise one pound of flour from 50 to 51 than it does to raise one pound of the same flour from 70 to 71 degrees. Now, if the temperature of the flour was the only factor to consider, it would even then be more simple to get the proper dough temperature, but the variations of shop temperature must also be considered, the size of dough, etc.

After many experiments with doughs of from 1 to 4 barrels of flour, my advice is this: Never have water over 85 degrees (or 90 maximum) for mixing a dough in winter or under 65 degrees (F) in summer, no matter what temperature the flour may have.

Of course you will ask, "How are we to get a dough of 80 or 81 degrees when the flour is 86 or 88 in summer or only 60 or 65 in winter?" There are a number of methods given by different expert bakers for determining temperatures. Some recommend to deduct flour temperature from the required dough heat and add the difference to the dough heat, the result being the temperature for the water. This would mean, take the water at 101 deg. F. In another book the method of multiplying the required temperature of the dough by 2 and subtract the temperature of the flour with allowances, brings the water to 104 degrees. Now I have a fixed standard which acts as a guide. Temperature of flour is taken in the flour bin, every morning, before the mixer begins his work and marked down on the dough sheet. The condition of the weather and outdoor temperature is also marked down. The dough room is kept at 78 or 80 degrees, summer and winter. We know from

the previous day's record of temperature, how much water to hold back to be added to doughs at a higher temperature. The reason for not mixing the flour with water over 85 degrees is this: Water over 85 degrees will dissolve the soluble gluten immediately it gets in contact with it, and at the same time the cold flour, say at 65 degrees, will chill the water very fast. By adding a small quanity of water, even if boiling, after the water and flour is mixed together, the extra heat in the hotter water will add many thousands of heat units or calories and raise the temperature as desired.

Of course, every baker should have a fixed standard of calculating or figuring the temperature of the water required according to the temperature of the flour, shop, and outside temperature; of course, some judgment must be used or allowance made for prevailing conditions; but, whenever the water temperature is required to be above 85 degrees, mix your flour with water at 85 degrees, holding back one or two gallons. When flour is all well mixed with the water, take the remaining amount of water many degrees hotter (even if boiling, it does not matter), and this water added at a high temperature will bring the dough at the required 82 or 84 degrees.

Pour the water on gradually while the mixer is running. By any other method you would perhaps require your water to be 102 degrees for 83 degrees dough. So on each pound of water we are 17 degrees short, which means 1,700 degrees short on the hundred pound of water. Now, take scalding water at 170 degrees, and the difference between 85 and 170 is 85. Therefore, 20 pounds of water (2½ gallons) at 170 degrees will give you the twenty times 85 degrees, or 1,700 degrees, which you need to bring the whole dough to 83 degrees, or give the same result as if you took all the water at 102 degrees.

When you have been using the water at 95 degrees, the flour not being quite so cold, and want to

take it now at 85 degrees, it would take only 100x10 or 1,000 degrees to add, or a trifle less than 12 pounds of water (1½ gallons) at 170 degrees. If you use boiling water to bring up the temperature of the dough, it requires a smaller amount.

Example: We should take 100 pounds water at 95 but wanted only 85 degrees, multiply the amount (100 pounds) by 95 gives 4,500 degrees. Next, multiply the temperature of the 100 pounds of water which we want to take at 85 degrees, and have 100x85 or 8,500. Therefore, we are 1,000 degrees short. One pound of boiling water, 212 degrees and the other water at 85 degrees shows a difference of 127 degrees. Divide the 1,000 degrees by 127 gives about 8 pounds (or one gallon). Consequently, if we use water at 85 degrees, instead of 95 and keep one gallon back, to be added at the boiling temperature after the flour and water is well mixed, we will have a better dough.

To convince yourself that it is detrimental to the gliadin, and consequently to perfect fermentation, to use the water above 85 degrees, mix a little flour into a small dough with sufficient water at 95 degrees. Now try to wash out the gluten in water of the same temperature, and you will find a very small amount of gluten. The gliadin has been dissolved by the hot water. You repeat the same test making another dough, using water at 50 degrees or colder, and then try to wash out the gluten in water of the same low temperature, you find that the starch is hard to wash out, the whole dough being like a piece of leather. After you succeed in getting out the starch you will get a tough, stringy, gray substance which is glutenin. The smooth binding part (gliadin) again is missing. To get a perfect test, or gluten sample, you have to use the water for both operations, mixing the dough and washing out the starch, at a temperature between 68 and 80 degrees.

However, sponges must be treated different than straight doughs. Water must be taken colder, as the gluten (principally the gliadin) has been softened during the fermentation. I have found that the water should be taken much colder to pour on a sponge when ready to mix with more flour for dough. Salt and other ingredients may be added same time with water, the sponge broken up with the water and then let stand at least five minutes before adding the flour required. With an eight hour sponge this is still more important than with a four or five hour sponge. The cold water will draw the excess of heat from the sponge and stiffen the gluten, invigorate it to stand the mixing into dough without getting a sticky dough or a dead dough.

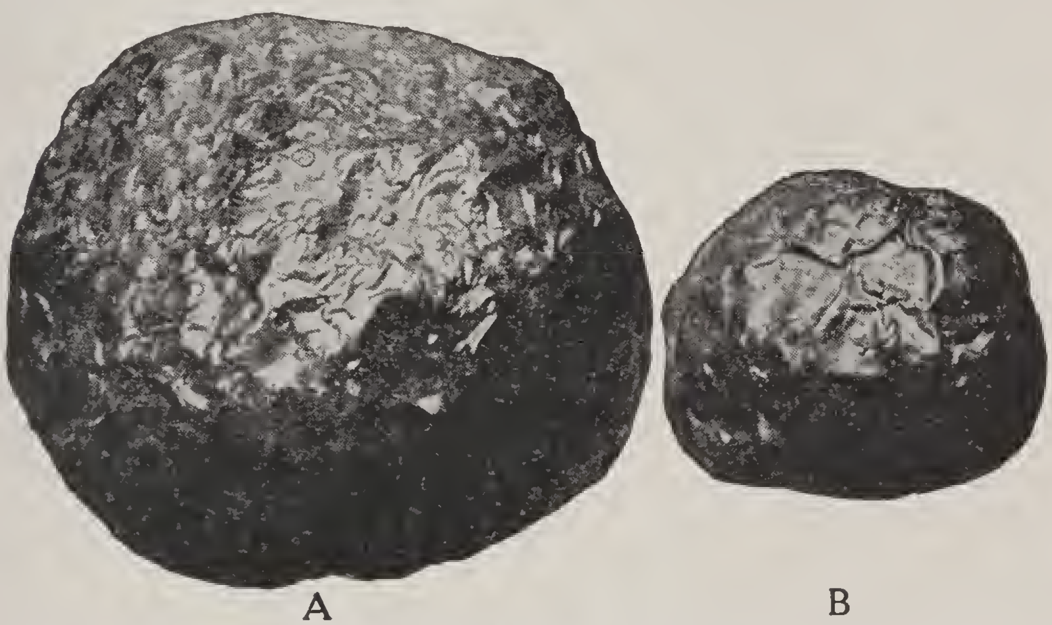


Fig. 2.—A, shows Gluten washed from 50 grams unfermented Dough; B, washed from eight-hour Sponge.

Example: Take a piece of sponge when it has dropped and is ready for taking; try to wash out the starch (to get the gluten) using water at 85 degrees or over. You will not be able to find any gluten. Take the water at 65, you save a few stringy, tough little pieces. Now put a piece of same sponge in water at 35 or 40 degrees, and you will be able to gather all the gluten contents left during the fermentation pro-

cess of the sponge. However, it is most all glutenin and has a gray dead color. It is about one-third of amount that you get by washing out same amount of dough made of water and same kind of flour. This explains my statement, that in hot weather the water for mixing the dough should not be taken below 60 degrees, no matter how warm the flour is. Keep sufficient water back (from one to two gallons) and later on, when dough is partly mixed, add that amount of colder water,—even ice water will not hurt. The large difference in degrees of the comparatively small amount of colder water will draw the heat out of the flour much better than when the whole amount of water is taken at a low temperature, which chills the gluten and retards fermentation.

After any dough is partly mixed (straight dough or sponge dough), especially in a mixer, with fast speed, it does not hurt, but rather improves, the dough to add a few pieces of ice, and let them run along in the mixer until the dough is nearly finished; then take them out, or if the ice has been chopped fine, it will have melted. This will keep the mixer and blades cool, and make a whiter dough and better texture.

Although I believe in fast speed mixers, I do not believe in over-mixing a dough for the sake of yield, being able to use a few pounds more of water to every barrel of flour. You do so at the expense of flavor.

BREAD FORMULAS.

In reality there is no such thing as a bread formula. Every baker has his own method of working out a formula suited to his own fancy or to suit his particular trade. One baker gets best results from one flour while the other baker condemns it. One baker told me that it is wasting money to use any dry milk in bread, while thousands of barrels are sold every month to some of the most progressive bakers; I myself have used hundreds of barrels. The same refers

to Malt Extracts and Shortenings. I have a collection of formulas of the leadinig loaf from a dozen large, successful bakers, in as many cities, and not two of these formulas are alike, and I have not copied either one myself but use one of my own get up. And as to some advertised kinds of bread, where a certain formula is furnished, the same has to be changed in different cities and bakeries according to conditions, and in some cases a different formula altogether is used, only retaining the name for advertising purposes.

Every baker has a regular formula for every kind of bread he makes and this we call a "basic" formula. For instance to one barrel of flour he may be using—14 gallons of Water; 1¾ pounds of Yeast; 2 pounds of Malt; 3 pounds of Sugar; 4 pounds of Lard; 3 pounds of Salt.

Then when he gets another flour or buys a higher diastasic malt extract, a richer shortening or a richer sugar, a different yeast, or runs short on yeast, he changes his formula accordingly.

As I had occasion in several large bakeries to start a system in the shop, I naturally had to find the easiest way of getting the men in the mixing room used to figuring and calculating. Now, we all know that there are lots of bakers to this day who figure the amount of water by "buckets" or pails. Some use 10 quart buckets, others 3 gallon buckets. To every bucket they figure a certain amount of salt, yeast, sugar, etc. Now, we know that this will not do any longer, in an up-to-date bakery, where the total weight of every dough has to be marked down. A baker generally figures a gallon of water at 8 pounds. I have made this more simple by figuring.—

25	lbs.	water	for	3	gallons
50	"	"	"	6	"
100	"	"	"	12	"

This is practically correct, as we learned that the weight of water varies at different temperatures.

With this method, even the retail baker using only two buckets for sponge or dough can figure out the number of pounds of water without using a pencil. For instance he wants to use 9 gallons or 3 buckets of water: Well, 6 gallon is 50 pounds and 3 gallon is 25 pounds, makes 75 pounds. Or, he used 2½ buckets (7½ gallon.) Now, 1 bucket is 25 pounds, 2 buckets is 50 pounds, and ½ bucket (1½gallon) is 12 pounds, making a total of 62 pounds, equal to 2½ buckets or 7½ gallons. Now when I want, for instance, 160 pounds of water, my men would figure it this way—100 lbs. are 12 gal., 50 lbs. are 6 gal. and the other 10 lbs. they figure as 1 gal., the result, 12+6+1=19 gallons or 6 1-3 buckets. It certainy does not cause a great mental strain to memorize these simple calculations. Then the rest of material can be figured out all based on 25 lbs. of water, say for—

WATER	FLOUR	YEAST	SALT	SUGAR	LARD
25 lbs. take	40 lbs.	6 ozs.	10 ozs.	12 ozs.	12 ozs.
50 " "	80 "	12 "	1¼ lbs.	1½ lbs.	1½ "
75 " "	120 "	18 "	30 ozs.	2¼ "	2¼ "
100 " "	160 "	1½ lbs.	2½ lbs.	3 "	3 "
125 " "	200 "	30 ozs.	3 "	3¾ "	3¾ "

Now, most bakers also figure a barrel of flour as their basis, but I find it is more reliable to take the water as the basis for all calculations in bread doughs. Our standard of buying and selling flour by the barrel of 196 lbs. is certainly very antiquated and even if we buy our flour in sacks which weigh 140 lbs., the amount is based on the barrel standard. We know that 7 sacks make 5 barrels or 980 lbs. but the miller does not quote us price on 1,000 or 10,000 sacks, but so many barrels although it is all delivered in sacks. I hope the day is not far distant when some cental like the Metric System of Weights and Measures (Kilogramm and Metre and their decimals) will become the universal standards, and we can buy flour in packages of round figures.

BREAD STANDARDS.

There have been attempts made in several cities to pass ordinances for the purpose of establishing standards of quality for all kinds of bread. Food inspectors, health officers and doctors are sometimes over zealous in their effort to protect the public against fraud and deception and the baker comes in for a good share of the accusation.

They can not understand why a Gluten loaf of bread should contain anything but pure gluten flour or a graham loaf be made out of graham flour only, or they call it adulteration or unlawful to use any white flour in Rye Bread. Now the baker knows that the public would not buy a Graham loaf made out of graham flour only, because it would appear as if it was made out of sawdust, or a Gluten loaf out of all pure gluten flour would not hold together and very few people do relish a loaf of Rye bread made out of even three-fourths parts of pure rye flour, to say nothing about all rye. Of course if a baker is trying to use the very lowest grade of wheat flour like "red dog," he is hurting his own interest more than the public, because he cannot improve his bread that way, and although he can save some money on the cost of such flour, he not only gets an inferior quality, but also a smaller yield.

Many people, even many bakers imagine that Winter Wheat flour is added to a bread dough only because it is cheaper. But that is not so. By adding 10 to 15 percent of rich, soft winter wheat flour most bread doughs are improved, because we get a richer dough and a better flavored, better colored, loaf of bread; and, too, we can reduce the amount of shortening and sugar or other yeast food.

After thirty years of practical experience it is my conception—*"that the actual value or standard of any Flour or Standard of Bread is depending on the ability and experience of the baker."*

One of the most successful bakers made this characteristic remark: "It is a poor baker who has to buy all first Patent flour to make a good colored, good looking and good tasting loaf of bread."

BAKING TESTS, whereby the loaves are baked in tins, are easier for measuring the expansion of the loaves, but are not as reliable as to the actual strength of the flour, as if we make the loaves for such tests in "Cottage," "Vienna" of any other hand-made shape and bake them on the hearth of the oven. The pan loaf has only one direction of expansion and a weak flour can be helped along with yeast, yeast foods, etc., and will hold up in oven. With the loaves set on the hearth, each loaf has to depend on its own inherent strength and if the flour is weak the loaves spread or fall flat. You make a set of pan loaves and an equal set of "bottom" or "hearth" loaves from different kinds of flour and put them in the same oven. You will not find much difference in the appearance of the pan loaves from the different grades of flour all made of the same formula. A number of hearth loaves, each made from the same formula with different flours, will show different results. Some will crack on side, some will run flat, and some will be too tight and round and some may be just right. Therefore it will be an advantage to have different flours for different kinds of bread; for instance, for sponges you can use a stronger but cheaper flour, and in dough making add some of a very fancy patent for flavor and bloom only.

CRACKING OF BREAD CRUST. It frequently happens that bread cracks on top, especially if baked on the hearth like Rye and Vienna Bread. The cause of this is that too much steam is used in the oven. For instance we make several thousand five-cent and ten-cent large loaves of a certain kind, which are proved with very little steam, and baked without any steam in the oven. They are not required to get a glossy finish, but in the hundreds of thousand loaves

baked in a year, I never noticed the crust of one loaf being cracked, and crust is always tender and brittle, not tough. If you use steam in oven, turn it on before bread is put in and then as soon as bread has stopped expanding or raising and starts to color, you must turn off steam altogether, as the bread creates sufficient steam itself. In some cases it is even adviseable to open steam damper, especially as in large heavy bohemian rye and cottage loaves. When bread is taken direct from oven into a cold bread room, or to the wagon, the crust will also crack on top every time. It should be kept in the warm bakeshop until it has cooled some and the moisture or steam inside the loaf has all escaped.

There is another kind of cracking of bread. The loaves will crack on top or side, especially hearth bread, when two are set too close together, or when the steam is not sufficient, or too dry. (See part 5 Steam, Ovens.) The Vienna and Rye will also crack open when sponge or dough is too old.

COLOR OF BAKED LOAF.

Color of flour is not exactly a guide as to the color ob the baked bread. For instance we make two kinds of bread—Buster Brown and Home-made—from the same blend of flour. The amount of ingredients used in the two doughs—yeast, shortening, milk, sugar, malt, and water—are exactly the same; the only difference is, for the Buster dough we use 12 to 16 ounces less salt and 30 pounds less flour than for the Home-made to 400 pounds of water. The temperature is also alike, but the Buster loaf is whiter than the Home-made loaf. This I trace to the smaller amount of salt, principally. The more salt, the darker or richer the color of the loaf in crumb and crust. This is especially noticeable in bread made from sponge dough. I may further mention that both have a distinct flavor and texture. To give the Buster a richer looking crust, I use steam in the oven, while the Home-made is dusted with flour and baked without steam.

KEEPING BREAD MOIST.

CORN MUSH. Cooked flour (gelatinized) or a mush made from fine white Cornmeal is a very good retainer of Moisture in Bread. Before we had Malt Extract, we used a good deal of such mush in pan bread, especially the homemade kind. There are now corn preparations on the market, which are already cooked or steamed or otherwise prepared, taking the place of cooked mush, which together with Malt Extract, make also a good yeast-food. Absorbing from 100 to 200 percent more water than ordinary raw wheat flour, we also get a larger yield—more pounds of such mush to every 100 pounds of water in a straight dough can safely be used, but I would not advocate more, as the bread is inclined to become heavy and be more difficult to bake thoroughly. In damp weather during the summer such bread is inclined to get mouldy much quicker. Therefore, the amount used should be reduced in summer.

COOKED OR GELATINIZED flour answers about the same purpose as corn mush, only does not take up quite so much water, but gives a nice bloom and helps the flavor.

POTATO MUSH. Patatoes are another moisture retainer, and by the introduction of Potato Flour the use of potatoes has become much less laborious and more convenient. It gives bread a special flavor and also increases yield. But as potatoes in any form hasten fermentation, as any kind of yeast has strong affinity for them, more care must be observed to avoid "wild" fermentation or prevent bread going sour.

RYE BREAD.

The first consideration for making a good Rye bread is a good fresh Rye Flour. In large bakeries where a separate apparatus-blender, sifter and storage-bin are used for Rye flour, I recommend the use of pure Rye flour and a good first clear or second straight and sometimes a small amount of Hard Kan-

sas. Of course, where only a few hundred loaves of Rye bread a day are made, a good blended flour, Rye and straight or spring wheat already mixed at the mill are more convenient.

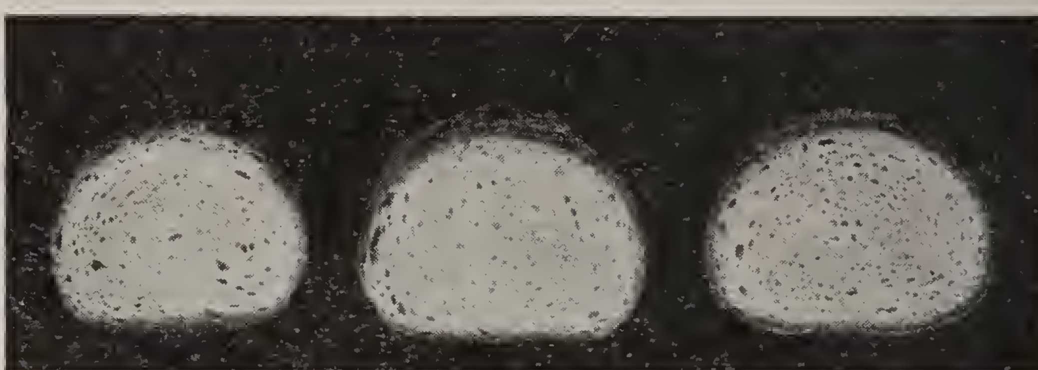
There are several kinds of Rye Bread made, Half Rye, Bohemian Rye, Sauer Rye, etc. For hardly any other kind of bread does the method differ so widely in different bakeries as for Rye bread. Some bakers make a very soft sponge with nearly all Rye flour, using two-thirds of the total water in the sponge. For the dough, they use nearly all white flour, straight or clear, and perhaps a small amount of Hard Kansas with it. Others use their regular blend, 2 to 2½ sacks of straight Spring flour to one sack of blended Rye flour, or 3 sacks straight or clear Spring to one sack of pure Rye in both sponge and dough, a little second Spring Patent or Kansas added to the dough. Some make a straight dough. In this case a piece of dough kept over from previous dough (not sauer) makes a larger loaf.

I use a medium soft sponge about 36 pounds of flour to every 25 pounds of water and pour on a half gallon more or 28 to 30 pounds for dough. A soft dough gives largest, best-grained loaf. I also add 2 pounds Sauer to every 25 pounds of water used in the sponge, but Sauer is mixed in doughing not in the sponge. Rye sponge should only drop once. Rye dough made from sponge should be allowed to get ready only once (when it breaks), then knocked down and only allowed to stand about twenty minutes the second time. For Bohemian Rye, I set a larger sponge with two-thirds of the total water and use more pure Rye flour in sponge and dough. For doughing use about same amount of Sauer as in half Rye dough.

This dough goes to the bench (or the divider) as soon as mixed, which makes a fine rounded loaf in the oven. This Bohemian Rye also needs a cooler oven, otherwise it will crack open. All Rye bread

requires plenty of steam in the oven until it starts to color. Rye flour should always be fresh from the mill; not over two or three weeks supply at a time being kept. It must also be kept in a cool place. I prefer Wisconsin or New York State Rye, and not too dark.

SAUER. I start fresh Sauer only once a week with say 3 ounces of yeast to a gallon of water and sufficient Rye flour to make a medium stiff dough, temperature not over 83 degrees. This will spring up nice and round and break like a cauliflower. Then freshen it up with 2 to 3 quarts more water, of about same temperature, and add more pure Rye, also a half pound ground caraway and 2 ounces of salt. When this breaks again, add from 2 to 4 quarts more water, the same amount of salt as before, more ground



A B C

Fig. 3.—A, Rye bread made from straight dough; B, Rye bread made from sponge dough; C, Bohemian rye bread made with "Sauer."

caraway and more pure Rye flour. By this time you can add scraps of white dough from the machines, etc., and later on all Rye scraps as well.

Some bakers have the mistaken impression, that any old pieces of sour dough and scraps will do for sauer, and think it should smell sour. Sauer dough must always be kept sweet by freshening up continually. When it once gets sour or bitter, you may as well start a new Sauer. Scraps do not hurt the Sauer, as long as it is always freshened up.

Sauer must be mixed thoroughly every time, and kept in a warm place. Keep adding ground caraway

and little salt every time you work it and every day, or every second day, a little yeast added will keep it fresh and sweet. I add salt for the purpose of keeping it from working in the dough as I only use the Sauer for flavor, and when made right and watched closely, it will be as sweet as a nut all the time. Only use pure Rye flour in Sauer.

Figure 3 gives an illustration of how I get about the same texture in Rye bread made with different methods. (A) is made from a straight dough (half Rye). But more yeast is required than for sponge dough and a piece of left over rye dough besides some Sauer. Say use 4 ounces of Sauer, 3 to 4 ounces of yeast and 3 to 3½ ounces of salt to the gallon of water. The loaf is a little smaller than the sponge loaf but very sweet and close grained and smooth. (B) is made from our regular half rye sponge dough, more water poured for the dough, than for the sponge. (C) is a Bohemian Rye loaf, for which less water is poured on dough than on sponge and taken from the mixer direct to the divider or bench. I use ground caraway in every rye sponge, besides what is mixed into the sauer.

BREAD BAKED ON HEARTH.

The one factor to be considered when baking any kind of bread on the hearth is the steam in the oven. You will find full information about Steam in Part 5.

The steam prevents the cracking of the loaf and keeps it in shape during its expansion in the oven. Steam produces a gloss or glaze on the crust, which is more natural than if bread is washed after it comes out of the oven. The glaze on Vienna in the oven is caused by the gelatinizing of the starch in the dough; in other words, by the formation of dextrin or gum while the crust is forming.

As any bread or rolls baked on the hearth are improved greatly in looks by a rich, dry gloss, we must help to get that gloss; it is even more important for this bread to keep it covered up during proofing (or

in a moist place) to prevent it from getting crusted. If that happens, it should be washed with weak starch wash before going to the oven. Or if there is not sufficient steam in oven, bread must be washed when it comes out of the oven; however, this must be done immediately or else crust gets very tough and wet. It is better to place loaves or rolls back in oven for a minute after washing them.

About Flour for Hearth Bread; that depends on the method of fermentation. For Vienna and French bread and Vienna rolls, the addition of some extra fancy middlings patent flour, (Spring or Kansas) from 15 to 40 percent. is the greatest improver, and helps more than any other material to produce a tender crust and delicious flavor. I would advise any baker, including the small retail baker, to keep some of the very finest Patent always on hand, even if he pays from 50 cents to a dollar more for it. The flavor of such fancy Patents I compare with the finest brands of Hungarian flour. I only advocate such rich flour as a special blend to improve the color, crust and flavor, so, reember, as I said, for Vienna, French Bread and Rolls, you just add this fancy flour to the dough, not in the sponge.

In one large bakery where we made about a thousand dozen "Wecks" or Butter Rolls (baked on the hearth) a day, we made a soft sponge (2 hours) with regular blend, and for the dough we used half of the Fancy Patent. To every Vienna dough we also used one sack of the Fancy Patent. A flour like No. 7 mentioned in the Laboratory and Practical Flour Tests (Part 3), is about the right kind for this purpose.

To illustrate my contention about such fancy flours which are made as a specialty by several large mills and sold at an extra fancy price, I give result of a test of one, which we shall call *Fancy Hungarian Patent*. The sample loaf made from the above was characteristically flat in proof; it sprang up better in oven. However, it would not stand up full, but sank

some. When it was cut after 12 hours, it was a darker yellow than Standard Spring or Kansas. However, flavor of crumb and crust was delicious, and crust a fine rich golden brown.

All bread baked on the hearth should first be rounded up and allowed to spring on before it is moulded up in proper shaped loaves. The effect of careless moulding is plainly demonstrated in Fig. 4.

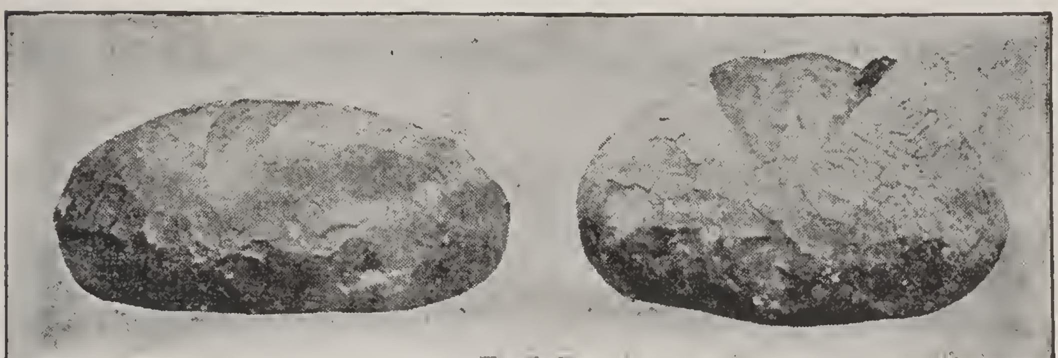


Fig. 4.—First loaf moulded loose; second loaf moulded tight.

The loaf in the right being moulded proper, sprang up fine and cracked perfectly in oven, while the loaf on the left, moulded up carelessly and too loose, ran flat in oven and did not crack. Both loaves are from same dough, made at same time and baked in same oven together.

TEXTURE AND GRAIN OF BREAD.

When cutting a loaf of bread, we first look at the cut surface, and from the regularity or evenness of the network of the little cells, most bakers form their judgment on the texture of the loaf. However, I call this only the grain. Some bakers may condemn a loaf having a very good texture, just because of their erroneous impression that the presence of one or a few larger holes destroys the texture of the loaf. In reality the holes can accidently happen in the best loaf, or perhaps in only a few loaves in a batch of a thousand loaves. This is illustrated in Figure 5, showing a loaf of bread fit to get a prize in any competition, judging from first cut, which shows it perfect

in grain, color and texture, and having a very smooth, velvety feeling. But, prompted by mere curiosity, I cut the loaf on the other end, and behold! several large holes were there. This deceiving fact struck me so forceful, that I had the two pieces (from the same loaf) photographed. Now, suppose I had cut the wrong end first and formed my opinion on the appearence or grain of the crumb? This proves:—

That real Texture is not the grain alone, as seen with your eyes, but it is decided by the touch of your fingers, the sense of feeling.

A B

Fig. 5.—A, Loaf almost perfect in grain, texture and color. B, Same Loaf cut on the other end.

When you rub the fingers over a fresh cut piece of bread and it feels like a piece of velvet, or in other words, "as smooth as silk," that is good, perfect texture. But when it feels rough and dry, coarse, or perhaps even crumbles away like sawdust instead of being elastic and smooth, that is poor grain. The real texture (judged by the sense of touch or feeling) is largely influenced by the temperature during fermentation; while what we may term the grain, depends mostly on the strength of the gluten and its development by stretching during the dough-mixing process. The holes in the loaf shown above are not to be considered at the expense of the real texture, as they were caused accidently. (See holes in bread).

PART 5.

Heat, Combustion, Fuel, Ovens.

HEAT.

The introduction of machinery and patent bake-ovens necessarily demands of the up-to-date baker a more or less technical education. The regulation of the temperature of water, sponge and dough, as well as the regulation of heat in bake-shops and the ovens, must be studied, and the principles governing them properly applied.

The heat in a bake-oven can and should be kept under control just as the engineer has perfect control over his engine or boiler. A pyrometer or thermometer should be attached to every bake-oven, whether made of brick or iron; indirectly (flue-heated) or inside (direct) fired. There are three different scales of heat measure; the Reaumur, Celsius or Centigrade and the Fahrenheit. To abbreviate these names on pyrometer or thermometer, the following letters are used: R. (Reaumur), C. (Celsius), F. (Fahrenheit). The freezing point on the R. and C. is marked at zero, 0, while on the F., it is 32 degrees above zero. The respective boiling points are marked at R. 80 degrees, C. 100 degrees, F. 212 degrees. In R. and C., reading the number of degrees below zero are marked "Cold," or "Minus" (—) degrees. Those above are marked "Heat," or "Plus" (+) degrees. By this you can readily understand how important it is to mention the system of "Scale" used when speaking of temperature.

To transform degrees of Fahrenheit into Reaumur, you deduct 32 from the F. degrees; multiply the remaining number by 4, and then divide by 9.

For example: 77 degrees F. are equal to 20 R; deduct 32 from 77, equals 45; multiply with 4, equals 180; divide by 9, equals 20.

To transform Fahrenheit into Celsius, deduct 32; multiply by 5, and divide by 9.

To transform Celsius into Reaumur, multiply by 4, and divide by 5. To transform Celsius into Fahrenheit, take the number of C. degrees 1 4-5 times, and add 32.

To transform R. degrees into C., take the number of R. 1¼ times. R. degrees are transformed into F., by taking the number of R. degrees 2¼ times and add 32.

Mercury has been adapted as the standard for use in thermometers, due to the regular and never-varying way in which it expands or contracts under normal conditions. The column of mercury in the tube of a thermometer seems to be round, and about one-sixteenth of an inch in diameter. As a matter of fact, it is flat, and a good deal finer than a single hair. Mercury does not expand to any great extent so it is imperative that we confine it in as small a space as possible. It is the magnifying effect of the glass that enables us to see it so plain. Spirits of wine is sometimes used, with coloring matter added, but it is not perfectly accurate.

Up till a few years ago, Mercury Thermometers for bake-ovens were not extensively used, owing to their frail construction and liability to breakage as well as constant separation of the mercury column. Modern manufacturing methods and new invention along this line have overcome these defects. There are now on the market two distinct styles of heat records. They are the Angle Thermometer and the Improved Pyrometer. In classing the heat indicators on the market to-day in two styles, I reserved the "Electric Pyrometer" for a class in which it stands alone. With this instrument, the height of achievement has cer-

tainly been reached. In most shops, while the oven-man is responsible for the appearance of goods coming from the oven, it is the foreman in charge who gets the blame for things going wrong. Think of the saving of time and worry for the foreman or superintendent who has such diverse things to keep his mind on, to be able at a moment's notice to stand at one end of a chain of ovens or in his office and see the temperature of every oven in the shop by simply throwing an electric switch. Could we wish for anything more simple and satisfactory? The movements and all parts subject to heat on these as well as the modern thermometers and pyrometers now on the market are made of non-corrosive material. They are all very sensitive, and the indicator shows instantly the slightest variation in temperature. The proper degree of heat for baking and handling of the above instruments will be more thoroughly mentioned under "Ovens and Firing." It appears that this part of the shop system has been grossly neglected in most bakeries, both large and small. If the firing of different styles of ovens is properly understood, a more uniform heat is acquired and a great saving in fuel is the result. Very few bakers have paid any attention even to the first principles of combustion and heat units. However, before we go into details of correct firing methods and kinds of fuel, a few facts on the principles of combustion will be necessary.

COMBUSTION.

Chemists classify all known substances either as elements, compounds or mixtures. We will deal only with the elements and compounds. Compounds are those substances which can by chemical action or by action of physical energy (heat or electricity) be divided into two or more simpler substances. These substances which cannot by any known means be further split up are called elements. The principal

elements we have to deal with in the combustion of fuel are:

Carbon ....C.
Hydrogen ....H.
Oxygen ....O.
Sulphur ....S.

In referring to these elements, it is customary to use the symbol or abbreviation which is usually the first letter. Thus, C stands for Carbon, and O for Oxygen.

Popularly, combustion means fire or burning. Exclude air from a fire, and the fire goes out. Oxygen is therefore necessary for combustion. Science has proved that oxygen has a great attraction for carbon, therefore, when these two elements are exposed, they rush together with great rapidity and force, and the chemical action is accompanied by light and heat. In combining in this way, they form an invisible gas, called carbon dioxide. The chemical symbol of this is CO_2. From this we plainly see that for every part of C or carbon present, we must have two parts of O, or oxygen. If we do not have these proportions present, a different gas is formed, producing through the chemical action, a larger or smaller amount of chemical energy, or heat. For instance, cut off the air supply, until you have but one part of O or oxygen for each part of C, or carbon, and these two uniting, form the gas Carbon Monoxide, the chemical symbol of which, is CO. When this occurs, that is, when less air is supplied, the combustion is said to be imperfect, and the carbon burns to CO instead of CO_2. The quantities of heat produced by the complete combustion of carbon in our fuel, is found by experiment to be as follows:

Carbon burned to CO_2 generates 8080 calories, or 14500 B. T. U.

Carbon burned to CO generates 2473 calories, or 4452 B. T. U.

By this you see we lose 5607 calories or 10,000 B. T. U., if the supply of air is not sufficient to burn it

from CO to CO_2. Calories is the standard name in referring to the table of Heat Units. A calorie of heat is the amount of heat required to raise the temperature of one gram of water, from 0 degrees to one degree, Centigrade. This is called the Gramme-Calorie or lesser calorie. For measuring larger quantities of heat, just the calorie is used. This is the amount of heat necessary to raise one kilogram of water, through one degree of Centigrade. The Gramme-Calorie is 1-1,000 part of the Calorie above mentioned.

There is another system of heat units used among engineers that depends entirely on British standards of weight and temperature. This is called the British Thermal Unit, and is abbreviated B. T. U. One B. T. U. represents the amount of heat required to raise one pound of water through one degree F.

To transform Calorie Units (metric system) into British Thermal Units (Fahrenheit degrees) multiply the former by 9 and divide by 5.

Usually the quantity of air admitted to the furnace, is from 50 to 100 per cent more than is necessary for the complete combustion of the fuel. This extra quantity of air enters the furnace at a temperature of from 60 to 70 degrees and escapes up the chimney at a temperature of from 400 to 600 degrees. A large quantity of heat is thus wasted and the temperature of the fire lowered. So you see that by being careful not to get too much draft, you overcome the loss of heat the same as by being careful that you have enough. Following are a few conditions existing in our fuels that aid or retard complete economical combustion, and they should be understood by all bakers.

The conditions necessary to consume the gases generated are the same as for the burning of the carbon, that is, a sufficient supply of air, allowing it a chance to mix with the gases at a high temperature in the furnace box.

Be sure that your fuel is not wet. The moisture of the fuel must be evaporated at the expense of the

heat produced by combustion. This moisture enters the furnace at the prevailing outside temperature, say 70 degrees, and passes up the chimney in the form of vapor, at 400 degrees or more. In producing this rise in temperature, thousands of heat units will be lost daily. Therefore, always keep your fuel under cover as far as can be helped, and never expose it to rain.

Oxygen and hydrogen are found in fuel in combination in the form of moisture. This is one reason for using fuels containing as small a percentage as possible of these two elements. Although black smoke contains quantities of small particles of unburned carbon, the heat loss is not as great as we might imagine. This is more thoroughly treated under the heading of Firing.

Now that we have a little better knowledge as to how our fuel is consumed, we will discuss the various kinds of fuel.

Comparative Table of Total Heat Evolved During Combustion.

Combustibles 1 Lb. Weight	Weight of Oxygen Consumed per Pound of Combustible	Quantity of Air per Pound of Combustibles.		Total Heat per Pound of Combustible B. T. U.
		Lb.	Air Cubic Ft. at 60° F.	
C to CO_2	2.66	11.60	152	14500
C to CO	1.33	5.80	76	4452
Average Coal	2.46	10.70	140	14133
Coke	2.50	10.90	143	13550
Wood	1.40	6.10	80	7792

Chemical Composition of Combustibles.

PECLET (Authority).

	Carbon.	Hydrogen	Oxygen	Nitrogen and Sulphur	Water	Ash	Total
Coal (Average)	.804	.0519	.0787	.0246	......	.0408	1.000
Coke	.850	......	......	......	......	.150	1.000
Wood (Dry)	.510	.023	.417	......	......	.020	1.000
Wood (Ordinary)	.408	.042	.334	......	.200	.016	1.000
Charcoal (Wood)	.930	......	......	......	.....	.070	1.000

FUEL.

Fuel is now such an expensive commodity that the economic ways in which it can be used, its quality, and power to generate heat, become subjects of great importance, wherever it is used in large quantities.

Fuel, as the word is ordinarily used, means all substances that burn in the air and produce heat. The fuels most commonly used are generally of an organic or vegetable origin. This includes all kinds of coal, peat, wood, coke, charcoal, as well as combustible gases and liquid fuels. All fuels consist of more or less carbon, an element necessary for producing heat. But hydrogen, oxygen, nitrogen, sulphur and ash are all substances found in the above list of fuels, and must be considered, as the quantities in which they are present influences the value of any fuel as a heat producer. The number of heat units they produce ranges between wide limits, and vary according to the chemical composition. The more organic oxygen present in

a fuel, the less heat produced, owing to its being in combination with other elements. Sulphur is also an undesirable element in fuel, as it does considerable damage by corroding the grate bars, flues, chimneys and oven fixtures. The more ash a fuel contains, also lowers its value for economic purposes, as less heat is produced and much time is lost cleaning fires and digging out clinkers.

Many of the large manufacturing concerns and institutions employing chemists, make a practice of determining the chemical composition of their coal. By doing this, they are enabled to buy only those fuels, coal or coke, having the largest percentage of heat-producing elements. This detail work in connection with fuel has not, to the author's knowledge, been adapted by any of our large bakers.

I will give a few practical pointers on the composition and action during combustion of various fuels, that may be of interest and value to the baking industry and the manufacturers of bake-ovens. Opinions about the most economical fuel for bakers' ovens differ, and local prices of material must be considered in the selection of the fuel.

COAL.

Coal is divided into four different varieties, the market price of which vary considerable. They are mentioned as follows:

1. Anthracite coal, which contains about 92 or more per cent of carbon.

2. Semi-anthracite coal, over 85 up to 93 per cent of carbon.

3. Semi-bituminous coal, which contains over 70 to 87 per cent of carbon.

4. Bituminous coal, which contains from 0 to 75 per cent of carbon.

ANTHRACITE COAL.

Does not ignite so quickly and requires a stronger draft to burn it. It is quite hard and shiny; burning with almost no smoke, gives it the preference over other coal in bakeries.

This coal is sold under different names, according to size into which the lumps are broken. They are named in regard to the dimensions of the screens over and through which the lumps of coal will pass, for instance:

PEA passes over ½-inch mesh and through 1-inch square mesh.

CHESTNUT passes over ¾-inch mesh and through 1½-inch square mesh.

STOVE passes over 1½-inch mesh, and through 2-inch square mesh.

EGG passes over 2-inch mesh, and through 3-inch square mesh.

Another advantage in using anthracite coal, is the fact, that its available heating power is practically constant. The semi-bituminous coals and all good caking, soft coals yield just about the same quantities of available heating power as does the best anthracite coal, but require more attention and raking and consequently the fire and heat is not as constant and uniform as if the former coal is used.

Anthracite is a non-caking coal. As stated, it contains more carbon than any other coal and the least amount of volatile matter (hydrocarbons) from one to ten per cent. The best anthracite coal is mined in the northeastern part of Pennsylvania, in the Lehigh Valley, Susquehanna, Shamokin and Lackawanna Districts. Occasionally, you get some anthracite coal which is flinty and hard as stone. It is almost impossible to ignite it; just glows like stone and the pieces frequently fly all apart in the furnace with a crackling noise like a gun explosion. Such coal is

called Graphitic Anthracite, contains from 1 to 2 per cent of gaseous matter and as a fuel is almost worthless. Graphitic Anthracite is found more frequently in the New England coal fields, especially in the Rhode Island Basin.

SEMI-ANTHRACITE coal has about the same composition as the anthracite, but, is not as hard and burns more quickly; it crumbles readily and is not as clean, but burns with little smoke. Contains from 8 to 12 per cent. of volatile hydro-carbons.

BITUMINOUS COAL.

SEMI-BITUMINOUS coal containing from 12 to 25 per cent. of volatile hydro-carbons is easily ignited, burns freely with little or no smoke and is used extensively for heating steam boilers. This coal forms a hollow fire.

BITUMINOUS COAL contains the most volatile hydro-carbon, varying from 20 to over 75 per cent. The nature and composition of this coal varies more than any other kind of fuel, therefore they are divided into three distinct classes:

1. Caking Coal are those which swell and fuse together, forming a solid, spongy mass when burned in the furnace or grate. Therefore the fire must be frequently broken down with a slice bar and cleared from the grate in order to admit the air to pass through.

2. Free Burning or Non-Caking Coal is so called, because it does not cake together as the above mentioned varieties.

3. Cannel or Gaseous Coal is very rich in volatile matter or hydro-carbons and therefore preferred for making gas.

SLACK is the name given to the dust or left overs from any soft coal after they are screened.

LIGNITE or BROWN COAL is the connecting link between Peat and Bituminous coal, the color varies from brown to black, absorbs moisture very rapidly

when exposed to the weather, which causes the lumps to break up and crumble quite readily. It burns quite easy and freely with a yellow flame and emits a tar-like disagreeable odor. However, its heating power is very low and it leaves considerable ash; is classed as a non-caking coal.

PEAT is the first product resulting from decayed vegetable matter, partly carbonized and being found in marshes and swamps; it generally is spongy and saturated with moisture, containing on the surface as high as 80 per cent water; deeper down where it is more de-composed, it is also more solid. Before being fit for transport or burning, it must be dried out, being cut or pressed into brighettes.

HARD COAL VERSUS SOFT COAL.

When caking coals are burned, they fuse at comparatively low temperatures, forming a crust over the top of the fire which prevents the immediate escape of the volatile gases that comprise from 40 to 50 per cent of the fuel's heating power.

These gases are then driven to the side of the fire-pot where they unite with the rising oxygen and, igniting at that point, are converted into volatile heating power.

When free burning coals are used, they disintegrate at comparatively low temperatures and some of the hydro-carbon gases escape without coming in contact with the necessary oxygen for ignition.

It makes quite a difference whether the coal is dry or wet. If it is wet, a large percentage of heat is necessary to bring up the temperature of the wet fuel to 212° first, in order to turn the water (dampness) into steam, and as a large percentage of this steam passes through the flues and chimney, that amount of heat is lost for heating purpose. As mentioned before, to raise the heat of one part (say one pound) of water one degree Fahrenheit it takes one Heat Unit. Therefore, if you pour one pound (one pint) of water at

60 degrees F. over the coal, it takes 152 Heat Units (B. T. U.) to raise the water from 60 to 212 degrees F. or to the boiling point and as it takes about 970 Heat Units (B. T. U.) to evaporate or turn this pint of water into steam, you need altogether 152+970= 1122 Heat Units (B. T. U.) This same example worked out in Calories would read like this: For one Kilogram (one liter) water at 15 degrees Centigrade or Celsius (60 degrees F.) it takes 85 Calories to raise this pint of water from 15 C. to 100 C. or the boiling point, and as about 540 Calories are required to evaporate or turn all the water into steam. you need altogether 85+540=625 Calories, which equals the 1122 British Thermal Units on Fahrenheit bases.

This example shows very plain that large quantities of heat are lost when damp or wet fuel is used.

COKE.

Is the residue left from certain kinds of Bituminous coal, when burned or heated with almost the entire exclusion of air and all its volatile matter driven off, leaving practically only carbon and a little ash. (see table.) It does not resemble the original coal at all; is hard, rough and honey-combed, and has a metallic ring, being much lighter than coal. Coke burns with almost no flame when combustion is complete.

GAS HOUSE COKE is a by product from the manufacture of illuminating or artificial gas and mostly consumed locally.

FURNACE COKE used to be made similar to charcoal in piles or mounds, but the demand having steadily increased, large Kilns and Coke Ovens of brick or stone have been erected for its manufacture. The most extensive coke centers are located around Pittsburg in the Connelsville district and the Alleghaney Mountain sides. West Virginia also produces considerable coke in the New River and Kanawha districts. Furnace coke is classed and its price fixed

according to the time it has been in the oven. (Carbonizing.) The standard kinds are known as 48 and 72 hour coke, the latter giving the highest number of Heat Units. Although the price of the 72 hour coke is from 50 to 75 cents per ton higher, it is the most economical, very light in weight, dry and uniform in size. Good Connelsville coke analizes as follows:

Carbon	88.00	to	89.00	per cent
Ash	9.50	to	11.00	per cent
Volatile Moisture	1.00	to	1.50	per cent
Sulphur	0.75	to	0.90	per cent

GAS

PRODUCER or ILLUMINATING GAS is distilled from coal. On account of its high price it is used very little for heating bake ovens. Its heating value is estimated at about 155 B. T. U. per cubic foot.

NATURAL GAS. In sections where a plentiful supply of natural gas has been discovered, it is used very extensively, and to-day is supplied from central stations to cities hundreds of miles away. The only trouble with natural gas is the inconsistency of pressure and in some localities the flow has given out entirely. Natural gas concerns claim that on an average, 20,000 to 23,000 feet of this gas has the heating value of one ton of coal. The principal constituent is Marsh Gas (Methane) $C. H_4$. The complete or proper combustion of natural gas is a problem which kept many scientists and engineers busy and experimenting ever since the introduction of natural gas for heating purposes.

The combustion of natural gas is a very difficult problem to solve. To be able to use this ideal fuel successfully, both from a commercial and financial standpoint, a few fundamental principles must be observed.

1. The proper amount of gas and oxygen must be brought in contact with each other.

2. After being brought together, they must be thoroughly mixed before reaching the point of ignition.

3. Combustion must take place before they have a chance to separate again, which they will do soon after being mixed.

The supply of proper amount of air must be watched, as a natural gas flame cannot exist unless supported by oxygen. Withdraw the air or oxygen supply, and the flame will be extinguished, while the gas will keep on flowing or escaping. Therefore, care must be taken when lighting a gas burner in any inside or furnace oven, that the dampers are first opened and that there is enough draft to carry away the product of combustion, otherwise there will be an explosion. It is a peculiarity of gas explosions that they strike back; that means through the open oven or furnace door. The writer witnessed several accidents as a result of such gas explosions, where the men opened the valves of the burners before they had the lighted torch applied. In bakeovens with direct firing (inside the oven chamber) the danger of explosion is still greater. But nine times out of ten, the man who lights the fire is the cause through his carelessness. The writer always cautioned his men to surely first open damper and oven door for a minute, to let any possible accumulation of gas in the oven escape before he puts his torch or light near the burners or grate, and only then open the gas valves.

One of my foremen was burned three different times through his carelessness. One time the force of the explosion striking back through the oven door, threw him clear across the shop against the wall, burning his chest and face frightfully.

As there may be a leak somewhere, unnoticed, it is the safest way to have an automatic pilot (small flame) burning all the time.

Air and gas may be compared to oil and water, as they will not mix unless they are violently agitated, and unless combustion takes place promptly after proper amount of oxygen and the carbon in the gas have been agitated, they will separate again and escape with-

out furnishing the desired heat. As stated before, complete or perfect combustion requires the union of one atom of carbon C. and two atoms of oxygen O_2. The gas people claim that they can use nearly 80 per cent of air with their gas.

A natural gas from Pittsburg district shows average composition of:

Marsh gas ($C. H_4$	67.00 per cent
Hydrogen (H)	22.00 per cent.
Nitrogen (N)	3.00 per cent.
Oxygen (O)	0.80 per cent.
Other gases, ...	7.20 per cent.

There are different styles of gas burners, but they do not all answer the purpose of heating bakeovens. The writer's experience with different gas burners will be explained later on under firing.

WOOD.

Is not used as extensively nowadays as a fuel for heating bakeovens, as it was before the introduction of Patent Flue and Continuous Bakeovens, except for kindling the fire. In a general way, one cord of the best hard wood is estimated to be equal to one ton of coal; one cord of soft wood is equal to ½ ton of coal. B. & W. Co. give a comparison of 2½ lbs. of dry wood to one lb. of bituminous coal in heat value. Of course these figures are calculated for heating Steam Boilers. For heating Bakeovens, I find heating value of wood closer to that of coal, especially in inside fired ovens. Green wood contains from 30 to 50 per cent of moisture. When perfectly dry, it contains about 50 per cent of carbon. An analysis of Oak has been quoted to be composed of 49 per cent carbon, 6 per cent hydrogen, 42 per cent oxygen, a little over 1 per cent ash and not quite 1 per cent nitrogen.

The heating value of wood varies from about 6,500 B. T. U. to 9,000 B. T. U. or an average of 7,700 B. T. U. per lb. (see tables, pages 6 and 7, part 5.)

OIL.

PETROLEUM is being used only in sections where coal is scarce and oil plentiful, especially in California, Texas and Wyoming. CRUDE OIL from Pennsylvania contains about 85 per cent carbon, 14 per cent hydrogen, 1.4 per cent oxygen which gives a theoretical heating power of about 20,000 B. T. U. but there is quite a loss of heat by evaporation, which reduces the number of Heat Units considerable. There is also danger of explosion. The Standard Oil Co. estimate that 173 gallons of their oil equal one long ton (2,240 lbs.) coal, allowing for all savings incidental to its use.

COMMERCIAL VALUE OF FUEL.

The commercial value of a given fuel for a certain amount of baking, can only be determined by an extended trial, keeping careful records, adding to the fuel cost, the cost of firing and removal of ashes. (See Oven Record cards). Keeping a record of same items under same conditions, but with different fuels, it may be found at times, that a low priced fuel can be more expensive than the real high priced on account of requiring more labor for firing and removing ashes, cleaning grate and flues since larger quantities must be burned to get the same amount of heat.

Anthracite Coal (small size) bought at $2.50 per ton will furnish about 10,000,000 B. T. Heat Units for $1.00.

Larger sizes like Stove and Egg at the price of $6.25 per ton furnishes about 4,500,000 B. T. U. for $1.00.

The heat value of various grades and qualities of Bituminous or Soft coal will lie between the above figures or average between 4,000,000 to 10,000,000 B. T. U. for $1.00.

Illuminating Gas at $1.00 per 1,000 cubic feet will yield only about 500,000 heat units for $1.00.

Natural Gas if sold for 10 cents per 1,000 cubic foot will give about 10,000,000 B. T. U. for $1.00.

Crude Oil selling at 4 cents per gallon will average 4,000,000 heat units for $1.00.

Kerosene selling at 10 cents per gallon is equivalent to 1,200,000 heat units for $1.00.

Nearly all liquid fuels (distillates) furnish about same amount of heat per pound, but vary greatly in cost.

One ton of Anthracite coal averages 25 bushel at 80 pounds.

One ton of soft coal averages 30 bushels at 65 pounds.

One ton of coke averages 40-50 bushels at 40 pounds.

A "long" ton of coal weighs 2240 pounds, but is only sold on these bases to dealers or car load buyers; the extra 240 lbs. being figured as allowance for loss or shrinkage.

OVENS.

All old time ovens were fired with wood and were built on the same principle as the ovens found to this day in most smaller bakeries in Europe, especially in country districts. These ovens are well filled with dry wood and then fired. When all burned out, the ashes are removed and the oven chamber *swabbed* out with a wet cloth fastened to a pole. Such ovens are called the old "Vienna" Ovens and are used to this day by a number of Italian and French bakers in this country, even in New York and other large cities. However, with the introduction of modern improvements a great number of different constructed bakeovens have been devised and placed on the market. They may be divided into different classes, according to their construction, method of firing or kinds of fuel required:

1. DIRECT or INSIDE fired ovens.
2. INDIRECT or FURNACE fired ovens.
3. CONTINUOUS BAKING or HOT AIR CHAMBER ovens.
4. HOT WATER or STEAM PIPE ovens.

Then again baker ovens are known irrespective of

the method of firing or kind of fuel used, under different names according to their mechanical construction, such as: Portable Ovens, Stationary (Brick) Ovens, Rotary, Reel and Drawplate Ovens, and now we have even Traveling ovens.

DIRECT FIRED OVENS.—In this class belongs first the old Vienna Oven as above mentioned, fired with wood. After the fire has been drawn, the oven is allowed to stand off for one half to one hour with door and damper tightly closed, to allow the heat to equalize through every part of the oven chamber. However, after two or three batches are baked, the chamber must be refired again. One german authority even refers to having the oven refired after every batch. His figures are:

For first baking, 100 Kilo Bread requires 32 Kilo Wood.

For second baking, 100 Kilo Bread requires 12 Kilo Wood.

For third baking, 100 Kilo Bread requires 8 Kilo Wood.

For fourth baking, 100 Kilo Bread requires 7.5 Kilo Wood.

The crown is built as low as possible and raised 10 to 14 inches in center, sloping on both sides from 4 to 6 inches, above the hearth or sole. Further, the hearth of the genuine Vienna Oven also slopes from back to front. The object of this is to keep the steam from coming out of the mouth or oven door. (See Steam.)

The author of this book has had some of these old style Vienna Ovens under his supervision, which were fired with natural gas. Two or three large gas pipes are run into the oven chamber extending about 18 inches into the oven, set at an angle towards the crown, with valves and air chamber on outside of the oven to the right of the oven door. When gas is turned on, long flames will stream along the crown of the oven chamber, diagonal towards the left rear wall

where the damper is located. After being fired from 2 to 2½ hours steady, the arches should show a white heat, and the hearth a bright red when gas is turned off. Being allowed to stand off for at least one hour, it is ready for baking. Steam being injected or water splashed in, these ovens bake especially nice milk or water rolls (hearth rolls.) After a few bakings, the gas is turned on again for from 15 to 30 minutes.

The more popular style of direct fired oven, very efficient for general baking, bread, cake and pies has the furnace placed inside the baking chamber on one side of the door in front, the damper being on the opposite side. After the fire is lit, the heat travels to the back of the chamber and then turns back to the flue to reach the chimney, or in more modern ovens, the heat chamber above the baking chamber. It is best to let oven rest awhile after damper is closed and fire covered or drawn, to settle the heat. The advantage of this oven is, that you can cool it down and get up a flash heat again in short time, which is of special value where small batches of different kinds of baked stuff are wanted alternately, depending on one oven.

The grate is set a few inches below the sole or hearth. Having no extra heat storage chamber, it is essential that the heat is allowed to linger longer in the oven, and a slow fire (or a larger fire banked) should be kept during the time there is no baking done.

This style oven is built as a stationary brick oven or portable oven, the out side frame being metal, standing on iron legs.

INDIRECT OR FURNACE FIRED OVENS we call such ovens which have a furnace underneath the oven-chamber, fired from front, side or rear, the fire or heat traveling around and over the top of the baking chamber, adopted principally for Portable ovens or as in Shelf ovens, where stove pipes are run through the baking chamber from the stove or furnace underneath. REEL and ROTARY also have a furnace below, but the heat strikes the baking chamber more

directly, as the furnace is open on top or only partly arched over the top.

REEL OVENS are used almost exclusively in Cracker bakeries, on account of the shelves or plates being so easily reached with the peel for filling and emptying, but are also used in some large bread bakeries for pan-bread. They are built on the principle of a Ferris Wheel. The baking blades are made of steel or sheet iron.

ROTARY OVENS have only one baking surface revolving like a Merry-go-round. These ovens have a tile or soapstone hearth and are mostly used for pie baking.

CONTINUOUS or HOT AIR CHAMBER OVENS are usually called Patent Brick Ovens and are the most popular for bread baking exclusively. The heat never strikes the baking chamber direct, being fired from the furnace below, either in front, side or back. The heat is accumulated and stored in chambers below and above the baking chamber, and no flame, smoke or dust can enter the same. The heat being stored, they are generally fired some hours before baking is commenced, and can be used continuously. These ovens are preferred for baking bread and rolls exclusively on account of the heat being constant and uniform, but are not so practical for a general baking, including bread and cakes on account of the difference of heat required. When once the baking chamber is allowed to cool down, as needed for cakes it takes some time to get it hot enough again to bake bread.

The baking chamber of the Continuous Ovens measures generally from 10 to 13 feet wide by 12 to 14 feet deep inside measurement. Of late, however, these ovens are built in much larger sizes with *wide mouth* or *two doors.* The hearth is from 14 to 22 or even 25 feet across, by 13 to 14 feet deep. Although these new features were looked at by the bakers very sceptical and considered in diametrical opposition to all theories and traditions of oven building, they have

apparently given complete satisfaction so far. A great saving of fuel and labor, besides offering many conveniences and better facilities for peeling and unloading.

HOT WATER OR STEAM PIPE OVENS are heated with a number of wrought iron pipes, located below and above the oven sole or drawplate. These pipes, are partly filled with water and hermetically sealed on both ends. The rear ends extend about a foot or less into the furnace which is usually at the rear of the oven. The furnace heat converts the water in the pipes into steam, and this steam being prevented from escaping, acquires a continually rising atmospheric pressure upon the water and a higher temperature is the result, which is transmitted from the pipes throughout the baking chamber. These pipes or tubes being first carefully tested as to their strength and flawless tightness, by exposing them to a considerable higher pressure than required for the baking heat, there is little danger of explosion. However, if in time any of the pipes should burst or swell, it is an easy matter to replace any single pipe with a new one, as they are not connected or dependent in any way on one another. The most popular Steam Pipe Ovens are the DRAWPLATE. The principle of these ovens which also accounts for the name, lies in the arrangement of the baking plates being removable from the oven chamber. The slower process of loading the oven with the peel, has led to the idea of building ovens with sliding plates, which can be withdrawn, loaded quickly, and running mechanically on wheels, pushed back into the oven. The objection to the extra space required, when plates are pulled out, has been greatly dispelled, with the construction of Double deckers, one on top of the other, practically taking only the space of a single decker, and reducing the cost of construction as well as the cost for fuel and operating.

TRAVELING or CHAIN OVENS have been in use in Europe for baking crackers and small sweet

goods for some years, and in this country for Matzos. They are equipped with a steel wire netting or steel plates fastened to endless chains traveling through the baking chamber which can be from 30 to 60 feet long; speed can be regulated, fast or slow. Attempts have been made lately to build this style oven for bread baking. The writer has had an opportunity to watch the baking process of the first oven of this kind built in America (in Montreal, Canada) and was very favorably impressed with the uniformity in baking, simplicity of mechanism and great reduction in oven help. The baking chamber in this oven is 50 feet long and 5 feet wide. The firing is done from a small tunnel built under the center of the oven where two furnaces are located, one running towards the rear, the other towards the front of the oven. It requires comparatively a small amount of fuel considering the amount of bread turned out in a day's baking, from 8,000 to 12,000 loaves and its capacity is claimed to be far above that amount, being a continuous baker.

FIRING.

The proper firing of any bake oven depends on the construction of the flues and heat chambers, the kind of fuel and the draft of chimney, and differs greatly from firing a boiler or larger furnace. I have twice tried the experiment to put regular firemen in charge of firing the bake ovens. Both men claimed to be expert firemen; one having fired on Railroad Locomotives, the other in a large power house. However, both failed to make good; they were so used to keeping on firing and poking and keeping up a lively fire, which we do not require for our Ovens. A well known baker remarked at a convention, "I am satisfied the fuel can be reduced twenty per cent or more, if it was handled with judgment, but it seems impossible to get laborers to use brains, they simply go on firing without using any judgment." Now, I never trust the firing of any oven to a cheap laborer, whether there is one oven or ten to be looked after.

When starting a new fire with coal or coke in a cold oven, you will have less smoke and less loss of heat by kindling the wood in the front part of the grate, throwing a few shovels full of fuel in the back part of furnace, to raise its temperature first to the igniting point before spreading it over the new fire, and you will not smother the flames.

When burning BITUMINOUS or Soft Coal, which as stated before contains large amounts of volatile or gaseous matter, I recommend the so-called caking system for firing. This means when charging the fire with fresh coal, *the coal is piled in the front part of the furnace as close as possible to the door and left there from 10 to 15 minutes.* As this coal is getting heated, the volatile matter (hydrocarbons) are driven off as vapor or gas making the coal carbonized or coked, and they will give more heat and make less smoke when later pushed back and distributed evenly over the fire, besides, these escaping gases while passing over the fire in the rear, yield a good percentage of heat (8,000 to 12,000 B. T. U.) Although soft coal is considered cheaper than hard coal or coke, it requires more care and judgment as they will produce soot and smoke, clogging up the flues and chimney and leave more ashes to be removed. The loss of heat from these causes is often as high as 50 per cent. (See fuel, page 11.)

Burning ANTHRACITE or HARD COAL, a smaller fire is required, especially in Patent Ovens. Don't smother the fire with piling too much fresh coal on top of it, especially if wet. (see fuel.) The smaller the size of the coal, the more you will choke or chill the fire and obstruct or prevent combustion, besides burning out the grate bars. (see page 9) Percentage of ashes varies from 8 to 24 per cent in hard coal. When coal is wet, the *coking* system mentioned above will be found of great advantage. Firing hard coal in Drawplate Ovens, I prefer Chestnut and Egg mixed. For direct firing Furnace Ovens, Egg Coal is the best size.

For Reel and Rotary Ovens, larger sizes are preferable; Egg or Stove or both mixed; but I prefer coke in either oven.

COKE, as stated before (see fuel) is composed of about 89 per cent pure carbon, or plainly speaking, gives 89 per cent heat and only about 10 per cent ashes. Many bakers make the mistake when burning coke, to start the fire too slow. The coke being honeycombed and leaving so much space for air to pass through, you should fill the furnace considerable more then with coal, and also pull the damper wide open, until there are no more dark spots to be seen in the fire. The arch as well as the coke must show almost a bright light red heat, which should take from 40 to 50 min. Then close the damper, leaving about one inch opening for the escape of the gases. After, say two hours from time of firing, you will notice no more flame or just the least bit of a bluish tongue of flame; then you close damper down tight, and the heat will last from 10 to 12 hours. Coke fires never need much shaking of grate or poking of fire. When once you have a solid fire, the most that may be required, is to pull damper two or three inches after several hours for 15 or 20 min. To get a good solid heat from coke, let first firing burn up brisk, then shake down or poke a little, to settle; then fire the second time which will be sufficient to last for a day's baking.

The most important rule to get best results from any kind of fuel in a Patent or Hot Air Chamber Oven is, to let fire draw brisk first, then close damper half until top arch and sides show bright red clear back to flues. This is what produces storage heat, because so long as the fire draws and the dampers are open, the heat will pass through the chambers rushing for the chimney. I can demonstrate the value of solid heat in a good Patent Continuous baking brick Oven best, from our own report of our average Friday's Baking (for Saturday) which means about forty-six thousand loaves. Our ten continous baking ovens which have

not been fired after ten o'clock Friday morning are almost continually used from one A. M. Friday to one A. M. Saturday, full 24 hours. No baking being done on Saturday, they stand idle, and instead of cooling off (with no fire in the furnace) the accumulated heat penetrates the oven chamber, and by Saturday we even open front oven door, (baking chamber) and smoke damper for several hours, to let the heat out and start baking Sunday morning with practically the heat left over from previous Friday. The fire started Saturday night will not have full effect until Sunday noon or at least 6-8 hours after being started. Just get the arch to white heat once in twenty-four hours, and you can bake bread continually. However, if such ovens must be cooled down for cakes, it is a matter of many hours to get the solid heat back again.

Ovens used exclusively for Hearth Bread must have a good bottom heat to give the loaves a good spring, otherwise they run flat. Drawing so much heat continuously, a larger fire must necessarilly be kept in the furnace, but little or no extra draft is required, the object being to keep the heat lingering under the Oven chamber as much as possible. An occasional rest is of great benefit and the Thermometer or Pyrometer will go up 20 to 30 degrees in a short time.

IF MIXED BAKING, Bread, Cakes and Pies are to be done in one oven, the DIRECT FIRED brick or portable oven is very popular. As already explained (see ovens) grate is set a few inches below level of oven sole. I advise a banked fire to be kept all during time there is no baking, and giving it before baking is commenced a slow draft to allow the product of combustion, seen in long pale tongues, to spread and linger along the crown or top of oven chamber. There are several styles of modern PORTABLE OVENS with furnace below the baking chamber which turn out a large amount of well baked goods. It is to be specially recommended, to start a moderate fire as long as possible before baking time to get a more uniform,

steady heat. Natural gas being used as fuel, I have always found it a fuel saver and heat preserver to pile some fire brick loosely in the fire box or furnace for the gas flames to pass around them.

Judging Heat by Color.

Temperature Fahrenheit.	COLOR.	Temperature Fahrenheit.	COLOR.
900°	Red (dull)	1900°	Orange
1200	Red (dark)	2100	Yellow
1400	Red (cherry)	2300	White
1600	Red (bright)	Over 2500	White (dazzling)

Melting Point of Different Metals.

Name.	Degree F.	Name.	Degree F.
Tin	446°	Copper	1996°
Lead	608	Glass	2377
Zinc	680	Iron (cast)	2450
Aluminum	1400	Steel	2500
Bronze	1692	Gold (pure)	2590
Silver	1873	Iron (wrought)	2912
Brass	1900	Platinum	3080

DRAFT.

Draft is a current of air, and as we have learned from chapter on combustion, air is the life of fire, and the briskness of the fire depends entirely on the proper amount of air supplied. Therefore, it is most important to have *proper facilities* to *increase* or *decrease* this current of air (Draft.) To control or regulate the draft, we need the draft door on the ash-pit (below the fire) and the damper in flues or chimney (above the fire.) They work in conjunction with each other. Either one worked alone will be a waste of heat or fuel. The draft door should be so arranged that it can be kept wide open, half open or nearly closed, or it must be perforated and supplied with a slide to regulate the air supply. The size of furnace depends on kind of fuel used. Soft coal being lighter than hard coal, requires more area for the same amount (by weight) as hard coal. When burning coke, the grate can be set a few inches below the dead plate in front and the bridge in back of the grate, a larger amount of coke being fired at one time, than coal. This is especially to be considered in direct or inside fired ovens. The grates, most always made of cast iron, do not only hold the fuel, but also admit the air, and for that reason must have open spaces between the supports. At least half the grate surface must be air space, the other half (the bars) serving to hold the fuel. There are different styles of grates used by different Oven Manufacturers. The single bar grate is very popular; about 2¾ to 3 feet in length. The thickness of the lugs on both ends determine the width of the open spaces of the grate. These bars are more or less sloping (thinner) on the bottom, which gives a better air supply. Another style used more for very small coal (as in boilers), is the ***Herringbone.***

SHAKING GRATES are preferred by many bakers and used in most all portable ovens, and are especially an advantage where the square fire-box or round pot is set below the furnace proper. Another

great advantage of a shaking grate, is because the furnace door can be kept closed while raking the fire, and no smoke or ashes will blow into the shop. The inrush of cold air over the fire through the open furnace door (the damper always being opened when shaking fires) is also avoided, which means preventing a loss of heat.

The furnace door should also be perforated and have a slide, especially when coke or soft coal, rich in carbohydrates are burned, as in this way, some air can be admitted over the top of the fire to mix with the gases which linger on top of fire, causing combustion of same. The admission of steam or water under the grate or furnace does not produce more heat, as some bakers imagine. It is only of benefit when coal are used, which stick to the grate bars or clinker badly; the steam coming from below will prevent this to some extent, keep the grate clear and also keep it from burning or melting. A better distribution of air and more complete combustion is the result, which also means indirectly, a saving of fuel. But, care must be taken not to admit too much steam, and I recommend the safer method of keeping a basin of water in the ash-pit, or better still, to have the bottom ash-pit cemented, and a few inches lower than the floor, keeping a small pool of water in same. Glowing pieces of fuel dropping through the grate will create sufficient steam for this purpose.

CHIMNEY AND FLUES.

The chimney answers two purposes; (1) to create a natural draft for the fire; (2) to carry off the obnoxious gases of combustion and the smoke. The area and height of a chimney and the position of its top outlet to the surrounding buildings, has an important bearing when erecting a chimney. Gases, hot air and smoke always ascend in a spiral column, which means, for instance, that a ten by ten-inch square chimney flue is no better or its practical work-

ing area no more extensive than a ten-inch round flue. There is also less friction in a round chimney flue than in a square one, because the spiral ascent of the draft moves more easily. The efficiency of the chimney (flue) depends on volume of passage due to area (size of flue) and velocity due to height of chimney. Therefore, the suction or speed alone do not make perfect draft; there must also be sufficient room to carry off the smoke. The chimney top should reach above the surrounding buildings if possible, as wind currents will rebound or be checked by walls or roofs in their way, and will force the air down into the chimney. It is also well known that there is quite a difference in draft of a chimney in summer or hot days and that produced in winter or cold days. On damp and murky days the draft is especially poor, and it is more difficult to get sufficient heat out of the fuel.

The outside air passing over the top of chimney. say ranges between 40 and 85 degrees on an average, while the hot gases passing through the chimney average from 400 to 450 degrees. Bulk for bulk, the outside air has about twice the weight of the hot gases In localities high above the sea level, where air is rarified or thinner, a larger volume of same must be supplied to get sufficient oxygen for combustion.

The wind or air currents passing over the chimney, carry off the gases or hot air and smoke as they come from the furnace, also create a suction or draft. With a high wind blowing, the fuel will burn away more or less briskly, even if the draft door (ash-pit) is closed as long as damper in chimney or flue is wide or even only partly open. The inside area of a chimney should never be less than 9 or 10 inches if round, or 8 x 12 rectangular, or 10 x 10 square, or always be a little larger than the end of stove pipe or flue where it leads into the chimney. Never have the end of stove-pipe, bricks or casing of flue, etc., extend beyond the inside surface or wall of chimney, neither allow any crevices or leaks, as the least obstruction prevents

the free passage of gas and smoke. The inside walls of chimney should be as smooth as possible. Some masons are very careless in this respect. The inside finish of a chimney is certainly of more importance than the outside, and every baker should watch the erection of any new chimney very carefully. Every oven should have its own chimney flue if possible, and no other flues or stove-pipes running into it. For a Two Oven chimney, it is best to allow a double area, and have a thin partition running up through the center. Sharp bends or offsets in the chimney will also reduce the area and choke the draft. If there is a soot pocket in the chimney below the point where the smoke-pipe or oven flue runs into the chimney, the same should never be deeper than one or two feet, and the slide or door of same must be kept closed perfectly tight.

DAMPERS are checks or valves in or above the chimney, and control the draft. On Continuous Baking and Portable Ovens, dampers usually have the shape of a slide, to be operated from front of oven, by a rod. On Draw-plate and Reel Ovens, the dampers generally consist of a drop door or lid, fitted over top of chimney, and are operated by a chain. The reason for the latter arrangement is, on Reel Ovens, especially used for crackers, there must be a constant flash heat and a quick draft and frequent manipulation of damper is necessary. On Draw-plate Ovens, the heating surface (see ovens) is so small, that the fire must be drawing nearly all the time, more or less, and the drop door on top of chimney is more efficient for the purpose. I would not recommend to have the inside area of chimney reduced toward the top, especially when solid fuel is burned, coal or coke. Some bakers think by running the brick chimney only half way the required length, and putting a pipe on top, they save money. But alas, they have more annoyance from smoke or poor draft, and do not get the full heat value out of the fuel. Theoretically, anthra-

cite or hard coal requires more draft than soft coal, but on account of the latter having a greater proportion of gaseous products of combustion, the flue area must be larger for burning soft coal than for anthracite. The height of chimney does not matter materially, but the difference in area of the flue required may be as high as 30 per cent, or a flue 8 x 12, good for hard coal fire, may have to be increased to 10 x 12 for soft coal. So, when changing from one coal to another, it is often well worth looking up the available chimney area. Coke requires a good draft, but burning easily without smoke, the area of chimney can be limited without danger to draft.

To clean out flues and chimney, I throw salt on the fire and open damper. Amount of salt depends upon area to be cleaned. The sulphurous gases eat the suds in a very short time. I use rock salt, from three to six pounds.

STEAM.

A certain amount of steam or moisture is required for the heat of the baking chamber during baking. The amount, of course, varies widely, and every baker knows that especially for Rye and Vienna Bread and Rolls, in fact anything baked direct on the Oven-hearth, a larger amount of steam is necessary, and the supply of steam must be replenished; therefore, it is essential that no steam can escape. In inside fired ovens, the direct fire leaves more or less moisture in the oven chamber. In smaller bakeries, with only one oven, perhaps a portable one, with no live steam supply, you may produce sufficient moisture by placing a pan of water near the fire-place and get it boiling. However, small boilers of sufficient capacity can now be bought so reasonable, that it will be a paying investment even for the small baker, as he can do all his cooking, pie filling, icings, mush, etc., in shorter time, and have a liberal supply of steam for proofboxes. Most Oven Builders also make it a point to supply steam or hot water boilers to their ovens on request. However, I prefer an independent boiler as a safer proposition,

as you can raise or lower your steam supply or pressure at any time with very little fuel and in a few minutes. For larger bakeries, of course, more steam and larger boilers are required. However, the pressure should not be over 30 lbs., and always carry plenty water in the boiler, at least 2 to 2½ gauges, to keep the steam moist. Dry steam or too much steam in oven is worse than not any at all. Some bakers think steam is steam, and always alike, and I have found it difficult to convince some of the old oven men that they can use too much steam. Of course, most ovens have a steam damper in the rear in the baking chamber, by which you can let surplus of flash heat and steam escape.

Steam for Bakeovens is best at a pressure from 15 to 30 pounds and the boiler should never be allowed to be less than half to two thirds full of water, indicated on the water gauge. While drawing the steam from boiler, you will notice the gauge (indicating the pressure) drop rapidly. Therefore, you must keep up a good fire. For this reason you may have 30 pounds pressure at the start; it will then be easier to keep it from going below 15 pounds, which is called one Atmospheric pressure.

Steam is like gas, expanding through application of heat. The temperature of steam increases with the amount of pressure (indicated on the gauge) as shown in the following table:

Pound Pressure	Temp. of Steam
0	212 degrees F.
5	227 degrees F.
10	239 degrees F.
20	259 degrees F.
30	274 degrees F.
40	286 degrees F.
50	300 degrees F.

At about 320 degrees, F. steam is thoroughly "dry" and will just do the opposite to your bread, from what it is expected to do.

It will cause it to be "blind," "shrink" the loaves or it will even "char" the crust. Now as the temperature of the Oven is about 450 degr. F., and on account of steam expanding with increase of heat, the oven will be full of superheated steam, when forcing it in quickly. "Through steam" or superheated is practically invisible. What you see issuing from the spout of a closed tea-kettle, is condensed steam and visible as vapor. The lower temperature of surrounding atmosphere chills or condenses the steam and naturally in cold weather you can see steam much plainer than in warm weather. You can notice that on your own breath. The only true steam issuing from the spout of a kettle or any other closed receptacle, (valve of a steam boiler, etc.) is contained only in the small space immediately in front or on top of the point, where it issues into the atmosphere. You can notice this empty space very plain wherever steam escapes.

Steam will always look for an outlet but does not descend below the highest point of exit, for instance, the oven door. For this reason, Vienna or Rye Bread Ovens are built sloping from back to front and the front door provided with a tin slide which can be lowered while peeling in Vienna or Rye Bread, to prevent the steam from escaping through oven door.

A strong kettle or pot with tight cover and spout is preferable. A very simple arrangement for any oven is to run a one inch pipe over the fireplace or if oven is fired from below, run pipe along the inside wall, of oven chamber; the pipe is connected with the cold water and is perforated. The pipe takes on about the same heat as the oven chamber and when you turn on a little cold water it will instantly turn into steam and spread through the oven.

OVEN RECORDS.

Every baker, no matter how small or how large his business should keep occasionally a record of a whole day's baking of one or more ovens, marking down the heat variations, fuel consumed, amount of

baking turned out, time oven is fired, etc. I refer to my own Oven Record Cards, samples of which I reproduce herewith (filled out). With these cards I was able to cut down the fuel gradually to less than one half the amount previously used. My fireman knows the character of every one of our ten ovens exactly, how much fuel every one requires, how often to fire, when to close dampers, etc., of course in our bakery the heat recording is much simplified as our Ovens are equipped with Electric Pyrometers, all operated from one switch-board and all recording the exact heat of each oven. I find that 450 degrees F. is the proper heat to start Bread Baking. I give here a record of the variations indicated on the "dial" of the switch-board for each oven, at different hours during one day's baking.

Record of Heat Variations.

Fuel	No. Oven	TIME AND DEGREES OF HEAT.					
		11 P.M.	2 A. M.	6 A. M.	10 A.M.	4 P. M.	8 P. M.
Coke	1.	435	450	430	420	430	435
Coke	2. X	440	445	395	390	405	435
Coal	3.	450	460	430	415	430	440
Coal	4. X	435	450	400	385	405	425
Coke	5. X	440	455	395	395	390	430
Coal	6. X	450	460	405	395	420	415
Coal	7. X	445	455	400	390	395	420
Coke	8.	450	450	440	435	430	445
	9.	Oven	in Re	pair			
Coal	10.	440	440	445	445	430	435

Ovens marked X are used for Hearth bread, which accounts for the drop in temperature. Firing started at 11 P. M., Baking started at about 3 A. M.

Electric Pyrometer

OVEN REPORT.

BRAUN'S "PRACTICAL" SYSTEM

Patent Oven.

Oven No. 1. **Date** 11/8/10.

No. Loaves	No. Sets	NAME	Time IN	Time OUT	Degrees HEAT	Time FIRED	Amount FUEL Soft Coal
300	60	Homemade	a.m. 4 20	4 47	460°	P.M. 10 00	60 lbs.
336	56	Cottage	5 00	5 33	450°		
300	60	Buster Brown	5 50	6 21	440°	11 30	90 lbs.
300	60	" "	6 49	7 20	445°		
300	50	Cottage	8 06	8 40	450°		
190	boxes 10	Rye	10 00	10 42	435°	A.M. 1 45	50 lbs.
171	9	"	10 50	11 35	425°		
144	48	Quality 10¢	11 50	12 34	420°		
300	60	Buster Brown	P.M. 12 58	1 35	435°	A.M. 5 00	60 lbs.
336	56	Cottage	2 40	3 14	432°		
180	boxes 10	Vienna.	3 45	4 23	430°		
270	54	Homemade	5 50	6 24	465°		
336	56	Cottage	7 20	7 44	470°		
200	40	Hotel	8 00	8 40	460°		
3663	Loaves						260 lbs.

Drawplate. Thermometer.

OVEN REPORT.

BRAUN'S "PRACTICAL" SYSTEM.

Oven No. 1 Lower **Date** 11/16/10.

No. Loaves	No. Sets	NAME	Time IN	Time OUT	Degrees HEAT	Time FIRED	Amount FUEL
						A.M.	Coke
—	–	——	—	—	475°	8^{30}	81 lbs.
168	28	Country	11^{48}	12^{15}	500°	11^{20}	36 "
192	32	"	11^{25}	12^{55}	500°	12^{00}	36 "
192	32	"	1^{19}	1^{47}	500°	—	—
86	—	Corn Bread	1^{50}	2^{22}	500°	—	—
						P.M.	
192	32	Country	2^{44}	3^{15}	495°	2^{30}	36 lbs.
156	26	City	3^{21}	3^{55}	500°	—	—
156	26	"	4^{03}	4^{37}	500°	—	—
156	26	"	4^{51}	5^{20}	500°	4^{30}	27 lbs.
144	24	"	5^{24}	5^{58}	500°	—	—
156	26	"	6^{02}	6^{36}	495°	5^{30}	20 lbs.
1598	Loaves						236 lbs.

PART 6.

Modern Bread Making, Machinery and Equipment.

MACHINE MADE BREAD.

It is an established fact that "machine" made bread is far superior to "hand" made bread; that there is a saving of at least 10 percent of flour to the barrel by reason of perfect sifting and loosening of the flour in the blending and sifting apparatus; that the mixing is more perfect; that the mixing machine does away with the hard labor; that the divider scales the bread more accurate and more quickly than men can weigh it by hand and that the moulding machine moulds the loaves more perfectly and more uniform. If you make sponge doughs, you also need a dough brake. All this means better and more uniform bread every day, which consequently means increased demand for bakers' bread. The missing link has been furnished by the automatic proving apparatus to recover the spring of the dough between the divider, or scaling machine, and the moulder.

Some bakers still look at machinery as an expense because it costs money to buy it. They do not seem to consider the same as an investment that will pay larger percent in dividends, or interest than the money would if it was invested in anything else. It will even pay to borrow the money from the bank and pay 5 or 6 percent interest (as some of the larger bakers do when making improvements), because the machinery will earn more through saving on labor, better yield, more uniform bread, better quality and increased sales

through better sanitary conditions. To sum it up, as an economical investment, machinery can't be beat.

It is positively proven that the employment of machinery has shortened the working hours of the men. The average output per man in a bakeshop equipped with machinery, increases from 20 to 40 percent, according to the efficiency of the system of regulating the working methods. Furthermore, a machine does not get tired, and when once adjusted to do the work right, it will do it right always, provided, of course, it is handled right.

Very true, indeed. But quite a bit of the blame is to be brought home to the machine man. Assisted by glaring figures and enticing testimonials, he shows the prospective customer how much he can save in labor, time and money. But as soon as a contract is signed and a machine set up and delivered, the baker is left with his fate and his machines. As it often happens, there is not a man in the shop who has handled machinery before, or, having been used to some other style of machinery, swears by *that one,* imagines that *that one is "it,"* and that no other will do. By proper adjustment of fermentation, handling of doughs, etc., it is not necessary that the machine "kill" the dough.

We must adapt ourselves and our dough to the character of the machine, and study the same. A baker must not expect to lay off a dozen men the first week he has installed a new machine; and after the work of the machine is satisfactory he must have one of the men at least made familiar with the construction of the machine, and held responsible to keep it properly oiled and cleaned. This man should also be able to take the machine apart and put it together again for the same purpose.

Now about the samples of the bread which are reproduced herewith. Figures 1 and 2 are from one dough (about 1,000 pounds). They are manipulated in different ways, and I leave it to my readers to judge

Fig. 1.—Loaf made up all by hand.

for themselves which is the better looking loaf in texture. In flavor they are alike, and both good. The other illustration (Fig. 3) shows a loaf of "machine-made" bread from a different kind of dough, fermentation being altogether different, long sponge and stiffer dough. None of these doughs have been "killed" with the machines.

In favor of machinery, which applies to Mixer, Moulding Machine and Scaling Machine (or Divider), I would mention as one of the strongest points in their favor, *"uniformity."* The more men you have in mixing dough (or at the scales, or on the bench),

Fig. 2.—Loaf from same dough (as Fig. 1), run through Brake, Divider and Moulding Machine.

the more different kinds of dough you have to reckon with, and the more light weight and heavy weight loaves you get, and the more different shaped and tight or loose moulded loaves will go into the proof room,—if the work is all done by hand.

If the different kinds of bread dough are to be run though the machines, you have to carry on your fermentation accordingly. Some bakers make all kinds of bread out of the same kind of doughs, while each loaf should have its own characteristics, flavor and texture.

Fig.3.—Pullman Loaf from old sponge dough, run through Brake (five times), Divider and Moulder.

One peculiarity of machine made bread is the difference between the action of the divider and brake on the same dough. The divider breaks the cells and makes the dough somewhat raw and wet, but does not reduce the acidity or gas to any great extent, and does not hasten the final fermentation or raising of the loaves in the *proof* room. The brake, on the other hand (provided it is not set too close), merely squeezes out the gas and acid, but does not break up the cells or the skin of the dough.

Run a piece from the same dough through the divider, and even through the moulder, and you will find the loaves raise quicker than if the brake had

not been used. It will also be noticed that the divider will not deliver the loaves so wet or sticky if the dough is passed through the brake first.

Furthermore, if the dough is run through the brake before being deposited in the hopper of the divider, the scaling device on the divider must be set back at least one or two ounces. That means that for a sixteen ounce loaf it is to be set to only fourteen and a half, otherwise, the loaves will usually come out too heavy. The brake facilitates the work of the divider by rendering the pressure more uniform and regular. But this is not to say that the modern dividers are unsatisfactory, or to be condemned.

Some bakers claim that the brake destroys the flavor of the bread. This is only the case with over-fermented dough, and when run through the brake too many times..

There is no such thing as a dough mixing machine "killing the dough," or a dividing machine "bleeding" the dough to death, or the moulding machine "taking the life out of the loaf," if you understand the machines, and do not expect too much of either of them the first week or the first month. Use some judgment; have a bit of patience and perseverence; give the machines their proper care, and there will be no reason for "kicking" or disappointment.

I wish to say that too much must not be expected of the machines. They are of no use unless common sense is used; and unless it is used, you are no better off with them than without them.

FLOUR BLENDING AND SIFTING.

The first step in beginning work in the shop is the blending and sifting of the flour. Blending has already been explained, but I just want to mention the importance of blending again. I have found by mixing and sifting different flours together ahead and letting them stand as long as possible, improves the flour. For instance, a rich Winter and a hard North-

ern second Patent or straight sifted together improves the flavor of the Northern flour. I have frequently found that the amount of gluten recovered from a blend of two or three different flours is larger than the amount of gluten recovered from each flour reparately added together. This cause is the action of the soluble albuminoids of the softer flour on the gluten of the harder flour.

One of the fundamental rules is *"that all flour used must be sifted."* The extra time required will be well repaid by improving the quality of the flour and giving better yield in the dough.

There is no reasonable excuse possiblle, even in the small shop without machinery, for using flour without sifting. Not only must we make sure that all impurities and strings, fuz, etc., are removed, but we areate and improve the flour by sifting. Even the flour used for *dusting,* either on the bench or on the machines, should have our special attention, and only sifted flour should be used. Because this flour is used *raw,* it is of more importance than most bakers realize. I have found that it pays *"to use the highest grade, best flavored and best colored flour for dusting."* I have been amazed by the near-sightedness of some otherwise shrewd men in the baking business, making the mistake of buying an extra cheap flour, frequently off in flavor or color, for dusting.

I say don't do it; it does not pay. You use every means to improve your bread, but reduce the quality willfully (if unconsciously) by adding raw, unfermented flour of inferior value at these last stages of the process of making a good loaf of bread. For Rye bread I also found it of advantage to sift some of the best flavored pure rye flour together with some dry wheat flour for dusting in moulding the loaves.

Mixing the Dough. If this is done by hand, dough wants to be well shaken down and frequently kneaded and cut over. However, as a one barrel dough takes

one horse power continuously to mix and knead a dough of from 15 to 20 minutes, it will require several men to produce the same dough in that time, as one man cannot deliver more than one-sixth of a horse-power for any length of time. The increase in yield is due to the machine or mixer, develops the gluten better and makes dough smoother. Dough Mixers are now made in sizes from 1½ to 6 barrels capacity, to suit any baker, and the so-called self-contained mixer (which means electric motor attached directly to mixer, without any shafting, extra pulleys and belt transmission) is especially adapted for the smaller bakery, where room is limited.

The starting box or switch-board should be right handy in front, if possible on the right side, so that the man in charge can reach it at any moment with his hand, to turn on or stop the power. Mixers with one blade do not require as much power as those with double blades. For a smaller shop, having only one mixer, it is advisable to have a two speed arrangement. Also figure one or two horse power more than is actually needed.

There are now on the market whole outfits for the smaller bakery, including bread mixer, flour sifter and blender, cake mixer and egg beater, all driven by one motor and taking comparatively little space. These machines can all be run together, or each one alone, by arrangement of clutches.

If mixer is very cold in winter, it is advisable to let it run for a few minutes with a little boiling water or take only part of water for first sponge or dough and make this thirty or forty degrees warmer, to warm up mixer before adding balance of water and flour.

Where sponges and doughs are made in one mixer, a two speed machine is of special advantage. Sponge can be mixed as fast speed, so also all smaller doughs and slack doughs. Sponge does not need to be broken

up so much as for hand made dough. The mixer, by either stretching or pulling (by double blades) and kneading and pressing (by single arm blades) obliterates every little piece of the sponge, thus making the dough smoother or homogeneous.

A machine made dough when newly made, feels more solid and tougher than a hand made dough; the former being mixed more solid and much closer in texture. Although I am not in favor of running a dough at too slow a speed (not below 22 revolutions) I am not in favor of over-mixing a dough. I believe where a dough is mixed to the limit, to get the gluten to absorb all the water possible, it gets like rubber and expands with the gas; very large, thin bubbles appear on top of such usually very slack doughs; those break, the gas escapes, and considerable of the flavor goes with it. I call this excessive, and as a proof that it is forced energy, I mention that in such slack doughs mixed to the limit, the amount of yeast used is generally nearly double the amount as used in the warmer, little stiffer doughs mixed slower say 400 to 450 revolutions.

There is not as much of a saving in using eight or ten pounds more water to a barrel of flour, as may be expected, because more yeast must be used, and that is more expensive than flour. Of course dough gets whiter, and texture or grain more uniform,—but all at expense of flavor. There is also such a thing as getting too much air, especially oxygen into a dough by running the mixer long at fast speed. This has been explained before as to its effect on sponges and stiff doughs.

TEMPERATURE IN DOUGHROOM AND PROOFING ROOM.

Excessixe heat in dough room and proofing room closets must be avoided. With temperature at 85 degrees or over in the dough room, or 92 or over in the proofing closets, or steam room, the dough in bulk

(in trough) or in the pans produce too much gas (CO_2) and too much acid, and in consequence fermentation becomes "wild." The gas cells, or rather gluten cells, holding the gas, in any sound dough which has been mixed and raised under proper conditions, are regular during any stage of fermentation. Pulling up a piece of any sound, cool dough, and stretching it after it has stood about two or three hours, it will show a network of regular uniform web-like meshes, which, (if not neglected in the proofing and if baked in proper heated oven) will show the same network only in smaller meshes when baked. There are two distinct species of cells in the grain of any loaf of bread, the same as in the dough; they are

In a dough made at a temperature of 80 degrees or less and mixed very thoroughly and not too soft, and not containing over three ounces of salt to the gallon, the cells are mostly oval and regular. These, as a rule, also cut smoother, and texture is firmer. The other specie of cells (round and looser) are predominant in a dough of 83 degrees or over and not mixed so long, and containing from 3½ to 4 ounces of salt to the gallon, such as Home-made Bread, New England, etc.

If either of these doughs, however, are allowed to go beyond the regular calculated time for fermentation or proofing, for some unavoidable reason or delay, or through neglect of the men, the grain becomes coarse, the color gets bad, and the flavor loses its sweetness. The only relief to remove coarseness and restore whiteness, is by rolling such dough through the brake. (See Part 6.) But if the loaves after being moulded are over-proofed or forced by excessive steam in the proof-room, there is no more relief. (See Part 6.) As mentioned before, the flavor of the bread is not controlled or improved by the grain or texture, and in some cases grain and color are only improved at the expense of the flavor.

ELECTRICITY.

Electricity is the most mysterious force or phenomenon in nature.

Although invisible, it manifests itself in various ways. The exact nature of electricity is still puzzling the wizards. They know the effects it produces, and by studying these, have found methods for controlling it, and have established laws and rules by which this mighty invisible power can be used and governed. Electricity is divided into three branches.

I. MAGNETISM.

There are natural magnets found in all parts of the world. They are an oxide of iron and called loadstones. They have the power of magnetizing and attracting other bodies to them. Artificial magnets are made by rubbing together a piece of steel and loadstone.

II. STATIC ELECTRICITY.

This appears as a charge on the surface of a substance.

This branch is noticeable principally in two ways; by friction and induction. (a) Friction is explained by the simple experiment of rubbing a piece of amber on a piece of wool. Heat is generated but it also attains the power to attract small pieces of paper and hold them to it, acting in this respect the same as a magnet. (b) Induction means to take one substance charged with electricity and by holding it near or placing it on a second substance the second also becomes charged. When a substance becomes charged, or electrified, the electricity it possesses is of two kinds. These are called positive (+) and negative (—). By experiment it has been proven that electric charges of the same sign repell each other, while those of opposite sign attract each other. This proven fact explains the

power of the magnet. Holding a foreign substance near a magnet it becomes charged with the + and — electricity. The + and — poles of the magnet then attract the opposite poles of the newly charged substance. The surface and space surrounding the magnet is called the magnetic field.

III. DYNAMIC ELECTRICITY.

By this we study or consider the flow or action of electricity in currents. In the preceding paragraphs the static charge was shown to pass from one body to another and after repeatedly charging one or more bodies its power to keep on charging becomes exhausted. That is if you can overload it, the charging power is so diminished that it has no further effect on the overload. Now if electricity could be supplied as fast as it is given off, we would only need to connect the positive and negative poles to maintain a continuous flow. This is what we call forming the circuit, and the flow which becomes continuous is termed the current. The battery both dry and liquid performs this duty for light work. But we will deal further on with dynamos and motors as these are the machines we have most in use in the bake-shop.

The principles of all dynamos are the same, that is they posses three essential features.

I. A magnetic field.

II. A conductor called an armature, in which the electro motive force is generated by some movement in relation to the lines of force in the magnetic field.

III. A commutator or collector from which the current is conducted to the main supply wires by two or more conducting brushes.

In practice, No. I is carried out by placing a number of electro magnets in the form of a circle. This leaves a round space or magnetic field across which the magnetic lines of force pass from one set

of magnets to another. No. II, revolving at a rapid speed in the space formed by No. 1, becomes charged or develops electricity. This electricity then passes on to No. III, which is a part of and revolves with No. II, and is carried to the supply lines through carbon brushes which rub or come in contact with the surface. The power to make No. II and No. III revolve in the space formed by No. I must be supplied by some mechanical energy, such as a steam or gas engine. So much for the dynamo.

The motor is practically the same as the dynamo. Owing to the different and varied work required of them they are constructed along different lines but still embody the same principles, namely magnetic fields, armatures and commutators, but motors are caused to revolve by electricity instead of mechanical power. The electricity is fed from the main line through the carbon brushes. Then the commutator and armature being charged are affected by magnetism from the charged electro magnets and are caused to revolve. A driving pulley attached to the shaft of the revolving armature is what gives us our mechanical energy.

The apparatus used in connection with alternating current installations differs in general from that used in connection with direct current systems and on account of the nature of alternating currents, the latter do not flow in accordance with the simple laws which govern the former. In direct current circuits the current flows continuously in one direction or in other words as time elapses the value of the current does not change. In alternating currents the direction of the flow is continually changing, and a current of a certain strength flows in a positive direction for a definite interval of time and then reverses and flows in the negative direction for a similar length of time

The complete set of values which an alternating current passes through, from zero to a maximum and back to zero in a positive direction and through

these same values in a negative direction, is called a *cycle*. The number of cycles passed through in one second is called the *frequency*. An *alternation* is half a cycle. The number of cycles of any machine can be found by multiplying the number of pairs of poles by the revolutions per second of the machine.

It is often preferred to express the frequency of an alternator in alternations per minute and therefore if an alternator has 60 cycles, i e 60 cycles per second (3,600 per minute) then, since there are two alternations per cycle, the alternator gives 7,200 alternations per minute.

Owing to the fact that the electro-motive-force called e. m. f. of an alternator does not reach its maximum and minimum values at the same time as the current, they are said to be out of *phase*. If the armature of an alternator is so wound that two circuits can be fed into it the machine is said to be *two phase*, and the currents in the two circuits differ in phase by 90°. Similarly if the armature is wound so that three circuits can be fed into it, the machine is said to be *three phase* and the currents in the three circuits differ in phase by 120 degrees.

The three phase motor with alternating current has proved to be the best adapted and cheapest for use in the bakery.

From preceding text, we now know that the magnets form that part of the motor which surrounds the revolving cylinder. The armature is the part of the motor which revolves in the space surrounded by the magnets, and the commutator is the copper part attached to one end of the revolving armature and on which the brushes set.

THE AMPERE is the practical unit denoting the rate of flow of an electric current or the strength of an electric current.

THE OHM is the practical unit of resistance.

THE VOLT is the practical unit of electrical potential, mean pressure.

ONE AMPERE is the amount of electricity that would pass through a circuit whose resistance is one ohm under the pressure of one volt.

ONE OHM is the resistance that would limit the flow of electricity under a pressure or electric motive force (EMF) to a current of one ampere.

ONE VOLT is the EMF or pressure that would cause a current of one ampere to flow against the resistance of one ohm.

QUANTITY, ENERGY and POWER.

The strength of a current is determined, as we explained in preceding paragraph, by the amount of electricity which passes the conductor in a given time, or in other words, the current strength expresses the rate at which electricity is developed. Therefore the quantity of electricity conveyed, depends upon the current strength and the time the current continues.

THE COULOMB is the unit of *quantity,* and is equal to the amount of electricity which passes the conductor in one second when the current strength is one ampere.

ENERGY, the unit used to express the amount of work done in mechanics, is known as the foot pound or the energy required to raise one pound one foot. In electrical work the unit of energy is the amount of work done when one coulomb flows between potential or pressure differing by one volt.

The unit of electrical work is therefore, the volt-coulomb and is called the Joule. One Joule equals 7,373 foot pounds.

POWER. In mechanical work the unit of power is called the horsepower. In electrical work the unit of power is called the watt. The energy of one horse-power is 550 foot pounds per second. The energy of one watt is one Joule or 1373 foot pounds per second.

One watt is equal to 1-746 of a horsepower or one horsepower equals 746 watts. The watt is too small for convenient use, so the kilowatt is generally used. This is abbreviated K. W., and is equal to 1,000 watts, or about 1⅓ horsepower. The K. W. is the amount of work done when one K. W. is expended for one hour. So one K. W. hour equals 1,000 watt hours. The K. W. hour expresses a definite amount of work while the K. W. represents the rate at which the work is done.

CONDUCTORS and NON-CONDUCTORS.

Conductors of electricity are such bodies or substances which offer a very weak resistance to the electricity or electric current to pass through them. Most metals, silver, copper, etc., are good conductors, so is charcoal and also the human body.

Non-conductors or Insulators are such bodies or substances which do resist the electric current very effectively in passing through them. Very useful substances as insulators are: Porcelain, Glass, Paraffine, Rubber or Gutta-percha, Oils, etc., also dry air resists the electric current, while moist air and ordinary water are very good conductors.

One can readily see from these few paragraphs how important it is when ordering machinery to correctly notify the manufacturer in regard to exact kind of motor and current in use in the shop.

Electric power has been one of the greatest helps towards enabling the smaller bakers to use machinery of all kinds. Dough Mixers are now made with the electric motor set under the machine and connected by gearing, thus saving floor space, using no more space than a trough would occupy when mixing by hand.

These machines are so built that the same motor can be used to drive other machinery, such as Flour

Sifter, Flour Blending Plants, Cake Machine, Egg Beaters and Dividers, so that quite a large installation, with a capacity of 50 barrels of flour per day, can be run with one motor under the Mixer.

The expense for electric power is small, being but one or two cents per barrel of flour, and the saving in labor in a shop where three to five barrels of flour are baked, will more than pay for an outfit of machinery in six months' time.

USING GAS OR GASOLINE.

Using a gas and gasoline engine there are several rules to be observed.

1. The comparison must be right, and the admission valve tight enough to admit just sufficient mixture (of gasoline and air) to take fire from the sparker.

2. The sparker must be kept clean, and work freely.

3. The valves must be kept well ground down with emery, and well oiled.

4. The spark must be made when the connecting rod is on the "up stroke," with the crankshaft two or three inches below the horizontal line of the center of the cylinder, which gives the greatest efficiency from the least amount of gas or gasoline.

PART 7.

System and Economy. Suggestions.

A BREAD BAKER'S DIARY.

I have found a daily record of unusual happenings or changes in the bakery quite useful for reference, and recommend this for any bakery. A few samples may be of interest:

JANUARY.

1st. Started new system in mixing room. Dough sheet is made out in the office for the mixer, giving him the figures for amount of each sponge and dough on printed sheet,—time to set, temperature, and he to mark down changes. It promises to work out all right.

3rd. Extra order for 50 loaves of rye bread came in too late to make regular dough. Took 100 pounds of last (just ready for bench) back into the mixer; added 30 more pounds of water, at 82 degrees, ½ pound yeast, 10 ounces salt and 35 pounds of rye mix flour (1-3 rye, 2-3 clear), also 5 pounds Kansas Patent. After mixing dough for about 8 minutes, let it rest only 10 minutes more, and put it on the bench. Made a nice large loaf.

4th. The first doughs all coming too fast and wild. Mixer insisted he made no mistake. Finally traced trouble to salt, being from a new sack opened, which was very damp. Got another (dry) sack and it was all right. If salt is wet, have to use more.

5th. (Saturday.) Ordered flues in two patent ovens cleaned out.

8th. Changed flour blend, adding 20 per cent Kansas Patent; but where Kansas is used, dough has better spring if not punched down; just pulled over to keep gas in and take to bench in shorter time.

9th. On account of heavy snow-storm had trouble with electric lights. In lighting gas found many burners missing, causing some confusion and delay. Burners will be kept on hand now.

14th. Changed half rye formula from sponge to straight dough. Use about 20 per cent strong Kansas patent, 60 per cent. clear spring and 20 per cent pure rye. Formula: 100 pounds water, 2 pounds yeast, 170 pounds flour, 2½ to 2¾ pounds salt, 3 pounds Sauer. Let come once good (3½ to 4 hours) then knock down, let raise second time, pull over and in half an hour it is ready for bench. Makes nice large rounded loaf. 6 to 8 pounds old dough is also advisable, but then it will be ready about half hour sooner.

15th. Started baking cut loaves (Butternut) in the Drawplate Ovens. By running steam into the baking chamber five minutes before bread went in the loaves were all perfect; no blind ones.

18th. (Friday.) Advertised almond coffee rings, 15 and 20 cents. Orders came heavier than expected and will try it again. Sprinkled chopped almonds inside, with the sugar, before rolling cakes up, and also sprinkled some shredded almonds (blanched) on top, with granulated sugar, after cakes were washed with egg wash before baking.

20th. Made some tests of molasses samples. Made a solution of 1 ounce soda with 16 ounces water. I mixed one ounce of this solution with 4 ounces of flour, 2 ounces of one sample of molasses, ½ ounce cooking oil. Put this dough in a little pan and

baked. Compared the different sample cakes, each being marked. Selected one (marked "O. P.") for best color and flavor.

21st. Car of Kansas flour taken in. Some bags were damp on bottom. Had them emptied and refilled in dry sacks, only the bottom part (damp) spread out for drying.

23rd. In cake shop corner a box of oily rags was discovered smouldering and burning from spontaneous combustion. Ordered all rags now to be kept in galvanized iron cans.

28th. Had motor thoroughly cleaned; was all clogged up. Vienna sponge taken too young and bread was small. Changed formula for buns, using now malt extract mixed with corn flour to a batter, letting stand a half hour; cut shortening and sugar down, using a little more yeast. Heavy snow still falling, after blizzard; traffic paralyzed.

29th. Ordered new daily record slips for cake shop, to start by first of month. Cut out some mixtures; material cost running over 55 per cent. Revised other formulas.

HOW TO PREPARE NEW PANS FOR USE.

New bread pans must be baked before being used.

This means they should be put in a medium hot oven (say between 350-400 degrees F.) for from 8 to 10 minutes, or until they take on a bluish tint like steel.

Then remove as quickly as possible from the oven, have one helper rub them out well with a rough but clean cloth, and grease thoroughly (inside) with pure lard. This must be done while pans are still very hot, so the lard can soak in. Let stand until partly cooled, then rub out once more with a cloth or a piece of dough.

Now the pans are ready for the regular greasing, which is best done with a round or flat greasing brush, as you must get into all the corners to prevent the bread from sticking, which happens so frequently with new pans.

Although pure lard seems rather expensive for this purpose, it is the cheapest in the end, because compound or cottonseed oil burns and gets sticky when the pans filled with bread are exposed to the heat in the oven during the baking.

Bread pans or cake tins, when greased with lard can be kept clean much easier. Keeping the lard melted it does not require very much of it to grease a large number of tins.

When properly greased, bread pans ought to last for two or three bakings before greasing again.

To save lard, grease them while they are warm.

The bread also has a more tender crust on sides and bottom when pans are greased with hog's lard.

Many bakers make a great mistake of greasing new pans first, before they burn them out.

THE CARE OF RUSSIA IRON PANS.

All large pans made of Russia Iron are more or less subject to getting rusty if not taken proper care of.

Before being used at all, they must be burned, but the same care as with the tin bread pans must be observed. Then rub well with a coarse cloth to get off all the acid and oily matter, which sweats out of new metal when thoroughly heated. While still hot, grease well with Oil or Compound and let stand for a day or so. Then rub the grease all off, heat pans once more, but not enough to burn, and rub once more with clean rags or waste. They are then ready for light greasing required in baking.

Never wash any Steel or Russia Iron pans with water, using neither soap, soap-powder or Sapolio, as you will destroy the finish and they will surely rust.

If such pans should accidently get rusty through exposure to dampness or water, you may apply a solution made of three parts gasoline and one part linseed oil. After rubbing in this solution well with a soft rag, let the pans stand long enough to allow the solution to soften the attack or dissolve the rust. Then rub off well with sawdust or cornmeal, to remove all odor of the gasoline or benzine.

Repeat this several times before heating the pans. Then heat the pans and grease with oil or lard. Rub off once more—best with an old piece of stiff dough. Some bakers have the habit of rubbing such pans off with coarse salt, which is condemned, as it scratches off the finish of the Iron or Steel.

MIXING ROOM RECORD.

Condition of Weather... Threatening snow, damp.

Outdoor Temperature... 34° – 36°

Temperature of Flour... 67°

Temperature of Doughroom 80°

DATE. Tuesday, Nov. 15, 1910

No.	NAME	TEMP. Water	TEMP. Dough	TIME MADE	YEAST		WATER		FLOUR		SALT		SUGAR		LARD		MALT		CORN FLOUR		MILK Dry		REMARKS
					Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	Lb.	Oz.	
1	Cottage Sponge 1.	84	82	P. M. 6 45	3½		300		530														
2	" " 2.	84	82	7 20	3½		300		530														
3	Buster Brown	86	83	10 00	5¾		530		850		13		18		17		5		25		4		
4	Rye Sponge 1.	82	82	10 30	3		130		190		—												
5																							
6																							
7																							

Fig. 1.—The above is a reproduction of a Daily Mixing Room Record sheet, on which a whole day's work is carried out. It not only shows the time when each Sponge or Dough is made, with temperature of water, flour and dough, condition of weather, etc., but also gives an exact account of all materials used.

Each column can be added up at the close of a day's mixing and the sheet can be used as a guide for the next day.

DOUGH ROOM RECORD.

CONDITION OF WEATHER

Date Tuesday, Nov. 15th 1910.

No.	NAME	Temp. Room	Temp. Dough or Sponge	Time Made	Cut 1	Knock Down 1	K. D. 2	K. D. 3	Time Ready	Temp. Dough or Sponge	REMARKS
				R.M.					A.M.		
1.	Cottage Sponges	80.	82.	$\cancel{6^{45}}$	—	—	—	—	$\cancel{2^{00}}$	85.	
2.	Cottage Sponges	80.	82.	$\cancel{7^{20}}$	—	$\cancel{2^{05}}$	—	[illegible]	$\cancel{2^{30}}$	85.	
3.	Buster Brown	81.	83.	$\cancel{10^{00}}$	—	$\cancel{1^{15}}$	2^{10}	$\cancel{2^{45}}$	$\cancel{3^{00}}$	84.	
4.	Rye Sponges	81.	82.	$\cancel{10^{30}}$	—	—	—	—	$\cancel{3^{00}}$	86.	

Fig. 2.—This sheet is made out in conjunction with the Mixing Room sheet (Fig. 1). It shows time when Sponges and Doughs are supposed to be ready for cutting over, knocking down and going to the divider or bench. The time is marked down in advance, and after the Dough-room man has attended to a Sponge or Dough he crosses the figures out.

If a Sponge or Dough is ready sooner (or later) than marked, the man crosses out the original figures and marks the exact time, as soon as he has attended to it.

TIME RECORD FOR BENCH.

DATE Tuesday, Nov. 15, 1910.

No.	NAME OF DOUGH	TIME STARTED	TIME FINISHED	NAME OF BREAD AND NUMBER OF LOAVES			
1	Buster Brown 1.	A.M. 3^{00}	3^{30}	Buster	1310	Grandma	125
2	Cottage 1.	3^{30}	4^{05}	Cottage	1400	Hotel	30
3	Cottage 2.	4^{05}	4^{50}	Cottage	432	Cream Square	660 360
4	Quality (Eatmor) 1.	4^{50}	5^{30}	Quality 10¢	562		

Fig. 3.—This sheet is kept by the Bench Foreman or the man in charge of the Scaling Machine or Bench, and shows the time when each Dough is ready in the Dough-room. It is also a good guide for checking the correctness of the scaling, whether done by machine or hand. Any mistake in counting is also shown up immediately, as you know exactly how many pounds each dough weighs, and how many loaves it should produce.

P. S.—The above three Sheets (Pages 6, 7 and 8) are kept on file (with a duplicate of the delivery list) for a whole week, thereby giving a complete record of every days' work for comparison. The sheets for each week are then all packed away together, for future reference.

BAKE SHOP DAILY RECORD.

(Especially adapted for Small Bakeries.)

Date......................*191*...

...............................*Dough*

...............................*Sponge*

Flour....................*Pounds*...... *Temp*.............

Water......*Gallons*.......*Pounds*......*Temp*.............

Yeast...................*Pounds* ....

Salt....................*Pounds* ....

Shortening................*Pounds* ....

Sugar ....*Pounds* ....

Cornflour or Flakes .... *Pounds* ....

Malt Extract.............*Pounds* ....

Milk.......*Gallons*.......*Pounds*...........

Time when mixed ....

Temperature of Dough when Mixed......*Degrees.*

Number of Loaves of Bread Baked............

Fig. 4.—The above is a handy Record sheet for the smaller bakeries, where only a few Doughs are made each day. One sheet is used for each Dough or Sponge.

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ADVERTISERS' SECTION.

NOTICE

I have made it a special point not to mention any firm, or any particular brand of material, machinery, ovens, etc. in the text of this book.

However, I have reserved some space for such leading Manufacturers and Millers, with whose product I am personally familiar, and for which I can vouch in every respect.

THE AUTHOR.

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